ATOMIC ICEBREAKER

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MAIN
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HEARINGS

BEFORE THE

COMMITTEE ON MERCHANT MARINE AND FISHERIES HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

SECOND SESSION

ON

H. R. 9196, H. R. 9978, and H. R. 10122

TO AUTHORIZE THE CONSTRUCTION OF A NUCLEAR-POWERED ICEBREAKING VESSEL FOR OPERATION BY THE UNITED STATES COAST GUARD, AND FOR OTHER PURPOSES

JANUARY 22, 23, AND 24, 1958

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ATOMIC ICEBREAKER

WEDNESDAY, JANUARY 22, 1958

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D. C.

The committee met, pursuant to notice, at 10 a. m. in room 219, Old House Office Building, Hon. Herbert C. Bonner (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

I want to welcome our new member, the Honorable Milton W. Glenn, of New Jersey. Mr. Glenn, we are delighted to have you assigned to this committee, and we look forward with much interest to your attendance and work with us on the subjects that this committee deals with.

Mr. GLENN. Thank you very much, sir.

The CHAIRMAN. Today we commence hearings on H. R. 9196, to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes.

The Chair is pleased that he has been joined by two other members of the committee, Mr. Tollefson and Mr. Pelly, who have also introduced identical bills, H. R. 9978 and H. R. 10122. H. R. 9196 will be inserted in the record at this point, as well as reports on this subject from the Department of the Navy, Treasury Department, the United States Atomic Energy Commission, and the Department of Commerce.

(The bill, H. R. 9196, and reports referred to follow:)

[H. R. 9196, 85th Cong., 1st sess.]

A BILL To authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, there is hereby authorized to be appropriated to the Treasury Department, United States Coast Guard, and the Atomic Energy Commission, such sums as may be necessary, to remain available until expended, for the construction, outfitting, and preparation for operation, including training of qualified personnel, of a nuclear-powered icebreaking vessel capable of operation in icebound waters of the United States, and in the Arctic and Antarctic regions as may be required. The Treasury Department, and the Atomic Energy Commission, in carrying on activities and functions under this paragraph, may collaborate with and employ persons, firms, and corporations on a contract or fee basis for the performance of special services deemed necessary by such agencies in carrying on such activities and functions. The Treasury Department may, for the same purposes, with the approval of the Secretary of the Treasury and where appropriate the Atomic Energy Commission, avail itself of the use of licenses, information, services, facilities, offices, and employees of any executive department, independent establishment, or other agency of the Government, including any field service thereof.

DEPARTMENT OF THE NAVY,
OFFICE OF THE SECRETARY,
OFFICE OF LEGISLATIVE LIAISON,
Washington, D. C., January 15, 1958.

Hon. HERBERT C. BONNER,
Chairman Committee on Merchant Marine and Fisheries,
House of Representatives, Washington, D.C.

MY DEAR MR. CHAIRMAN: Your request for comment on H. R. 9196, to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes, has been assigned to this Department by the Secretary of Defense for the preparation of a report thereon expressing the views of the Department of Defense.

This bill would authorize the appropriation of funds to the Treasury Department, United States Coast Guard, and the Atomic Energy Commission for the construction of a nuclear-powered icebreaking vessel for operation in icebound waters of the United States, and in the Arctic and Antarctic regions.

The Department of the Navy already has a long-range program underway for the application of nuclear power to surface ships as well as submarines. As a part of this program, the best uses of nuclear power in the field of ship propulsion must be determined, considering, on one hand, the desirability of fleet of nuclear-powered ships, and, on the other hand, the availability of construction facilities and necessary skills, the necessity for any particular type, and the costs involved. To date, 19 nuclear-powered submarines and 2 nuclear-powered surface ships have been approved and funds appropriated for their construction.

Preliminary design studies of a nuclear-powered Navy icebreaker have been conducted, and such a ship would have some worthwhile military advantages. However, construction of a nuclear-powered ship requires specialized skills and techniques, and, even though every effort is being made to expand our facilities and improve our techniques, all of our available resources for the immediate future should be utilized to progress toward the highest priorities in this field. Enactment of this bill might well delay the construction of other nuclear-powered vessels having a much higher priority and, therefore, it appears that the introduction of H. R. 9196 is premature. Accordingly, the Department of the Navy, on behalf of the Department of Defense, opposes the enactment of H. R. 9196.

The last sentence of H. R. 9196 provides that the Treasury Department may avail itself of the use of licenses, information, services, facilities, offices, and employees of any other agency of the Government. If this bill be enacted, it is recommended that this provision be amended to require the prior approval of the agency or agencies from which assistance would be sought.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Department of the Navy has been advised by the Bureau of the Budget that there is no objection to the submission of this report on H. R. 9196 to the Congress.

For the Secretary of the Navy.
Sincerely yours,

E. C. STEPHAN,
Rear Admiral, United States Navy, Chief of Legislative Liaison.

TREASURY DEPARTMENT,
Washington, January 15, 1958.

Hon. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries,
House of Representatives, House Office Building,
Washington, D. C.

MY DEAR MR. CHAIRMAN: Reference is made to the request of your committee for the views of the Treasury Department on H. R. 9196, a bill to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes.

The purpose of this bill is to authorize the appropriation of funds to construct and prepare for operation, by the Coast Guard, of a nuclear-powered icebreaking vessel. The collaboration and contracting for special services of persons or firms, civil and governmental, is permitted.

The Coast Guard is very interested in all aspects of development of nuclear power for the propulsion of vessels. However, in programing its needs for vessels of the many types which are required, including smaller types as well as cutters, there is not a present project for a vessel of the type suggested by the proposed legislation.

It is felt that the suggestion embodied in the bill might better fit the Coast Guard program at a later date and, for that reason, the Treasury Department does not favor the enactment of H. R. 9196 at the present time. This does not in any way negate the keen interest which both the Department and the Coast Guard have in the subject and in closely following such research and such development as is presently going on and will in the immediate future.

The Department has been advised by the Bureau of the Budget that there is no objection to the submission of this report to your committee.

Sincerely yours,

A. GILMORE FLUES,
Acting Secretary of the Treasury.

ATOMIC ENERGY COMMISSION,
Washington, D. C., January 20, 1958.

Hon. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries,
House of Representatives.

DEAR MR. BONNER: In your letter of August 9, 1957, you requested the views and recommendations of the Atomic Energy Commission with regard to H. R. 9196, to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes. We are happy to furnish the following report.

The bill would authorize the appropriation to the Treasury Department, the Coast Guard, and the Atomic Energy Commission of sums required for constructing and outfitting the proposed vessel and preparing it for operation, including training qualified personnel.

The Atomic Energy Commission, of course, is unable to advise you whether the Coast Guard will require the services of an additional icebreaker. We do feel, however, that, if such a vessel will be needed, it would be not only feasible, but advantageous as well, to use a nuclear plant as a source of power. The reasons for this conviction are stated below.

In the performance of its tasks, an icebreaker might be required to spend prolonged periods of time at sea at high power output without opportunity for refueling. The use of nuclear fuel could meet this requirement in a superior fashion.

Likewise, nuclear power, since its weight change is less sensitive to increased power output might result in a more efficient vessel, as this characteristic of an icebreaker is a function of power per unit displacement.

Moreover, if sufficient time were allowed for research and development, the development and operation of the nuclear propulsion might contribute materially to the advancement of reactor technology.

The proposed icebreaker would probably be more expensive to construct than a conventionally powered ship. However, in view of the offsetting considerations stated above, the utilization of a nuclear powerplant would appear to afford an excellent opportunity to demonstrate a peaceful use of atomic energy in a practical application. Accordingly, if the services of an additional icebreaker are required, we would recommend favorable consideration of H. R 9196.

The Bureau of the Budget has advised us that it has no objection to the submission of the report.

Sincerely yours,

K. E. FIELDS, *General Manager.*

THE SECRETARY OF COMMERCE,
Washington, January 21, 1958.

HON. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries,
House of Representatives, Washington, D. C.

DEAR MR. CHAIRMAN: This is in reply to your request of August 9, 1957, for the views of this Department with respect to H. R. 9196, a bill to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes.

The bill (in language similar to that of Public Law 848, 84th Cong., authorizing the nuclear-powered merchant vessel) would authorize to be appropriated to the Treasury Department, United States Coast Guard, and the Atomic Energy Commission, sums necessary for the construction, outfitting, and preparation for operation of a nuclear-powered icebreaking vessel capable of operation in icebound waters of the United States and the Arctic and Antarctic regions.

There may be some advantages to the American merchant marine from the construction and operating experience of a nuclear-powered icebreaker. While the operation of such a vessel would not be directly comparable to commercial transport, the application of nuclear power to propulsion of such a vessel should afford an opportunity for testing such propulsion in extended operation under rigorous conditions without dependence on an outside fuel supply, and without involving the risks of commercial transport of passengers and cargo.

Russia has launched a nuclear-powered icebreaker.

It is understood that the Treasury Department has its own technical organization for design and construction of its special-purpose ships. We defer to the views of that Department in respect of the specific need for the proposed construction.

The Bureau of the Budget has advised that it would interpose no objection to the submission of this letter to your committee.

Sincerely yours,

LOUIS S. ROTHSCHILD,
Acting Secretary of Commerce.

The CHAIRMAN. Last Tuesday, when I announced the commencement of these hearings to the committee, I emphasized that this legislation is a most important matter, and I pointed out that, with the application of nuclear energy to merchant shipping and the greatly increased responsibilities of the United States in the polar regions, we cannot act too soon to bring the Coast Guard up to date.

Since the *Wind* class icebreakers were authorized by this committee in 1941, there have been many changes in our concepts concerning the true interest of this country in the polar regions. Much experience has been gained, and much research has been done in those areas. Despite what has been done, however, I am told that we have not scratched the surface of the potentialities of the Arctic and Antarctic from the standpoint of either our security or commercial development. We do know that Russia has been for many years concentrated heavily on all aspects of Arctic research. We know that they have a legitimate right to claim a first in the development of icebreaking vessels and effiecient ship operation in the Arctic. Their discoveries have been such as to be both a lesson and a warning to us that to neglect the greatest possible development of our own Arctic areas would be both wasteful and dangerous.

Inasmuch as it has been many years since this committee has had occasion to consider problems relative to the Arctic and Antarctic, these hearings are scheduled in two separate, but consecutive, phases. First, I believe that it is important that we have the opportunity to be briefed by the best-qualified experts available on the entire question of the interest of the United States in the Arctic and Antarctic areas before proceeding to consideration of the legislation. Accord-

ingly, our first witnesses will give the committee some concept as to what problems and prospects are in the polar regions from the standpoint of servicing our military, of the status of our present knowledge of these areas, and from the standpoint of the equipment needed to make transportation more efficient, effective, and safe.

Following this portion of the hearings, we will then hear from the Commandant of the Coast Guard and Department of Defense and Atomic Energy Commission officials.

Our first witness today is Vice Adm. John M. Will, commander, Military Sea Transportation Service, who has had extended service and experience with this subject. Admiral Will.

STATEMENT OF VICE ADM. JOHN M. WILL, COMMANDER, MILITARY SEA TRANSPORTATION SERVICE, UNITED STATES NAVY

Admiral WILL. Good morning, Mr. Chairman and gentlemen. I have a prepared statement that I would like permission to read, and this statement is to be illustrated with some charts that I would like to project on the screen.

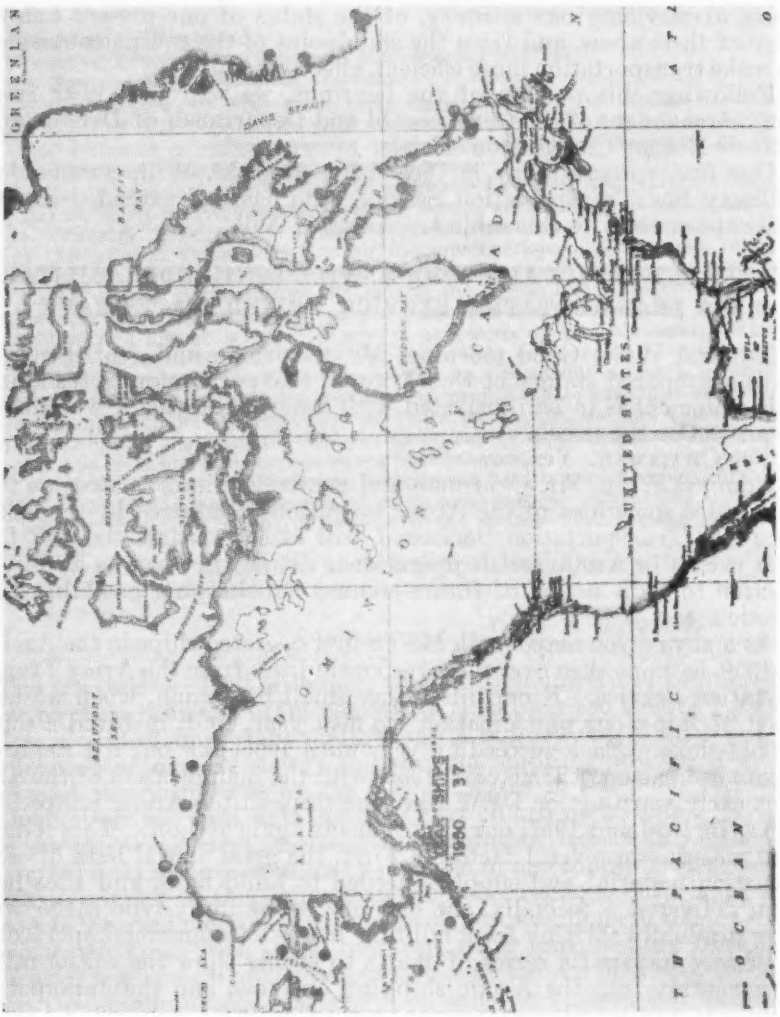
The CHAIRMAN. Yes, sir.

Admiral WILL. Mr. Chairman and gentlemen, in order to give the committee some idea of the Arctic operations conducted by the Military Sea Transportation Service, I will briefly outline some of the past events in Arctic sealift operations. This will serve as an introduction to a discussion of future commercial-shipping posibilities in Arctic areas.

As many of you may recall, MSTS first operated ships in the Arctic in 1950, having taken over these responsibilities from the Army Transportation Service. From this rather small beginning, when we utilized 37 ships, our participation the next year, 1951, involved a total of 144 ships. Each succeeding year until 1955, saw our lift requirements decreasing. That year, 1955, with the inauguration of the distant early warning, or DEW line, our ships in the Arctic jumped to 126. In 1956 and 1957, our requirements again fell off. This reduction was due to several factors. First, the great initial bulk of construction material and supplies needed to build bases and sites had been delivered. Secondly, the delivery of resupply-type cargo was very gradually shifting from military forces to commercial operators.

I have prepared a series of charts to briefly show the initial military venture into the Arctic shipping business, and the anticipated change to a primarily commercial venture by 1960.

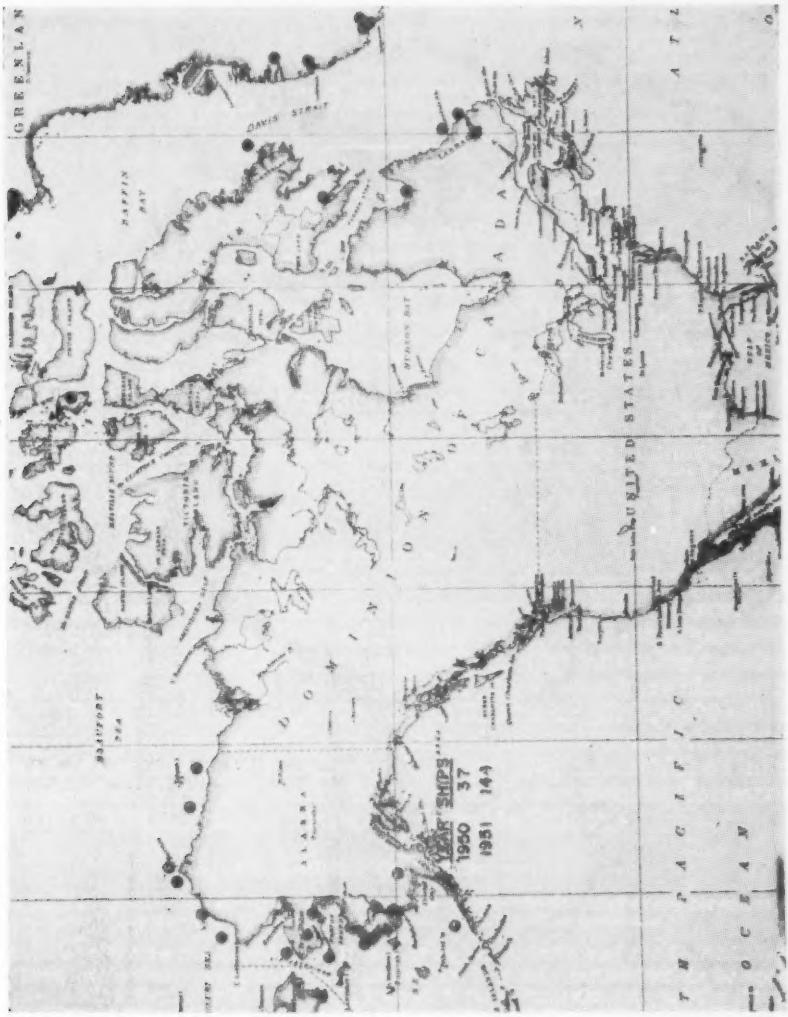
(Chart No. 1 follows:)



Admiral WILL. This is a basic map of the Arctic sector. The small dots are the bases, sites, or camps supplied by sealift. The overall number of ships employed during each year's seasonal lift are tabulated to give you an idea of the changing requirements from year to year.

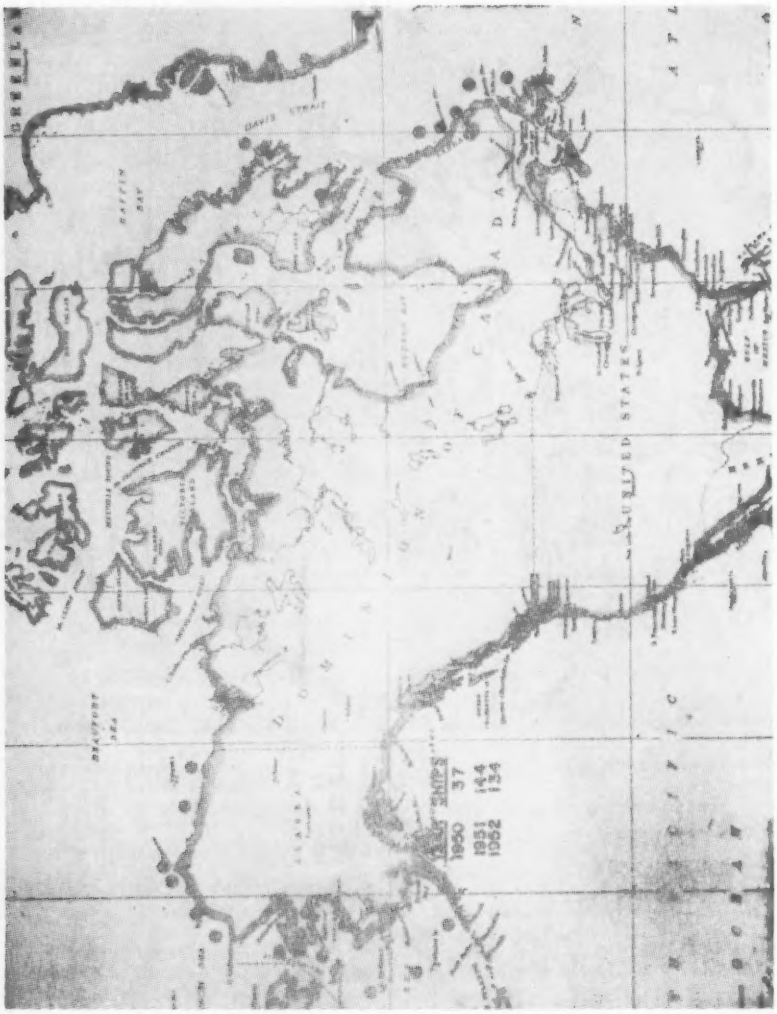
As you see here, the beginning in 1950 was limited. Shipping was assigned by MSTS to the Alaskan area Army resupply, to the naval forces in the Point Barrow-Barter Island regions. Ships in the eastern Arctic sealift dry stores and fuel to a limited number of bases in Greenland, and to the bases in the Labrador and Baffin Island areas.

(Chart No. 2 follows:)



Admiral WILL. In 1951, with Operation Bluejay (the building of the giant United States Airbase at Thule), the employment of MSTS shipping increased greatly. Under commander, MSTS, commander, Amphibious Group 4, and his staff were assigned the responsibility for the safe movement, to and from Thule, of all the ships procured by MSTS and for the coordination of the cargo-discharging operations at Thule.

(Chart No. 3 follows:)

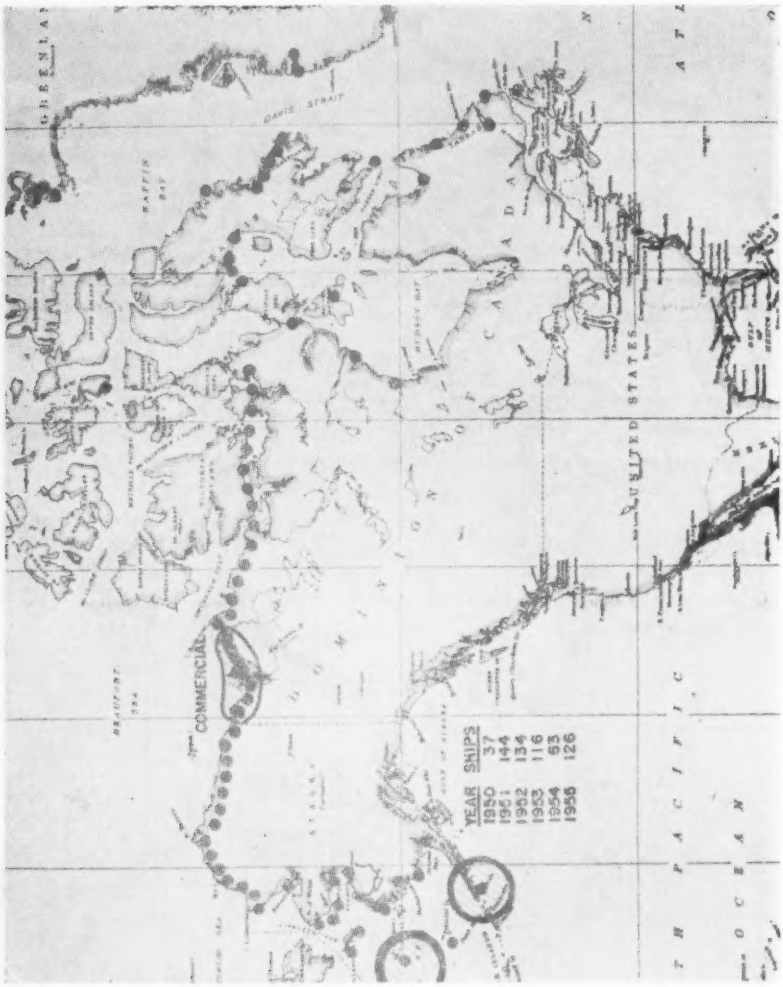


Admiral WILL. Following the extensive eastern area construction program in 1951 and 1952, shipping requirements decreased. These requirements provided primarily for the continuing resupply of the sites. However, there was some additional new construction, which contributed to the overall size of the sealift.

(Chart No. 4 follows:)

Admiral WILL. During the period from 1952 through 1954, our Arctic operations were confined to the seasonal resupply of existing bases.

(Chart No. 5 follows:)



Admiral WILL. This chart illustrates the expansion of our Arctic sealift in 1955. You can see that we were now required to carry construction materials and supplies to a greatly extended new area in the north. Note the commercial operations in the MacKenzie River area in Canada conducted by the Northern Transportation Co., and those at St. Mathews Island and Cold Bay in the Aleutians performed by an American barge line.

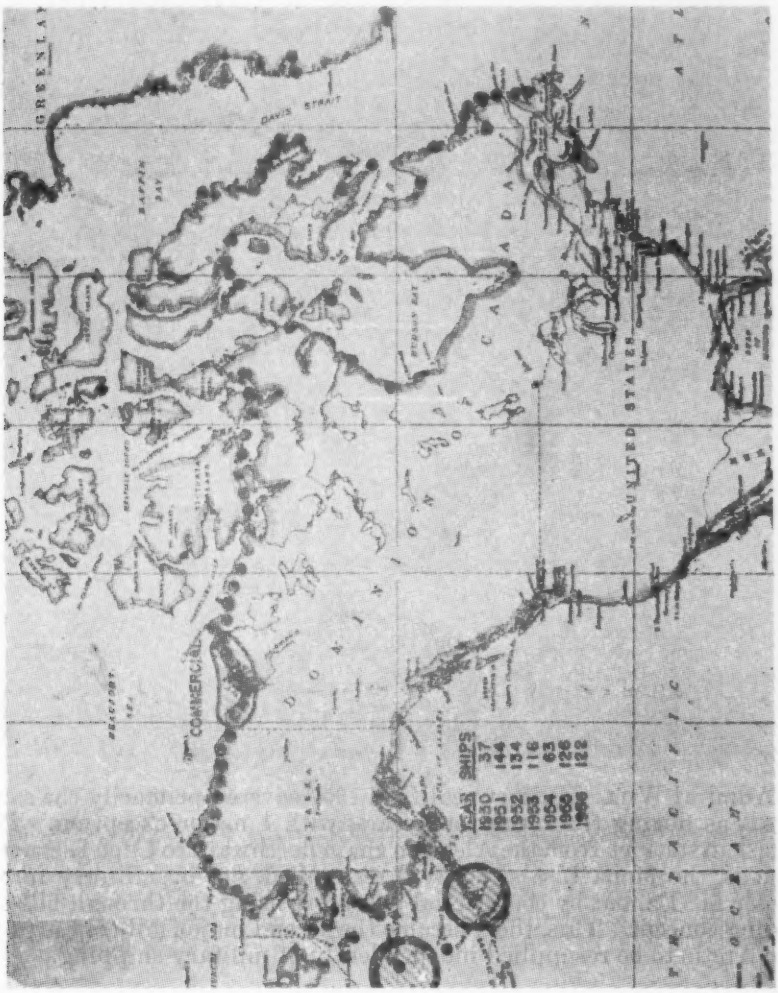
The DEW line, extending from the western Alaskan coast to Baffin Bay in the East, posed many new operating problems. Two separate operating forces had to be used, one from the Pacific around Point Barrow, 1,500 miles to Shepherds Bay; the other from the Atlantic, covering the relatively short distance into Foxe Basin.

The menace of the main polar icepack, lying close to the Alaskan coast nearly all summer, continually threatens shipping operations in that area. The eastward passage around Point Barrow must be delayed until this ice moves off the beach far enough to permit escorted transit, and that period in the last few years has been between the 28th of July and the 4th of August.

And of course the return passage must be carefully timed. In our 1955 operations a number of our returning ships were temporarily trapped by the ice closing in this area. It was this experience which initially pointed up the desirability of an escape exit to the east.

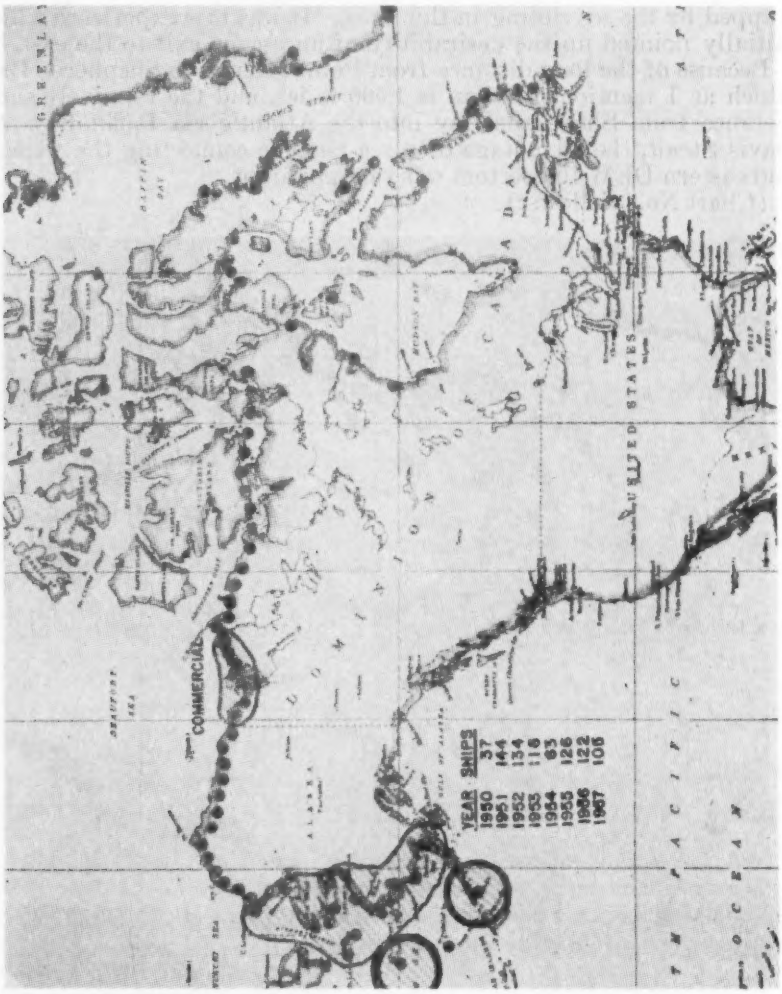
Because of the long distance from Point Barrow to Shepherds Bay, which as I mentioned before is 1,500 miles, and the relatively short distance from Shepherds Bay into the Atlantic via Baffin Bay and Davis Strait, the advantage of a sea passage connecting the western and eastern DEW line sectors was very apparent.

(Chart No. 6 follows:)



In 1956, there was little change in the number of sites or bases requiring ocean transportation. A few gapfiller sites had been added on the east coast of Labrador. These gapfiller sites are additional radar sites interposed and erected between the main sites in order to provide low level detection. Separate forces continued to be employed in the eastern and western areas.

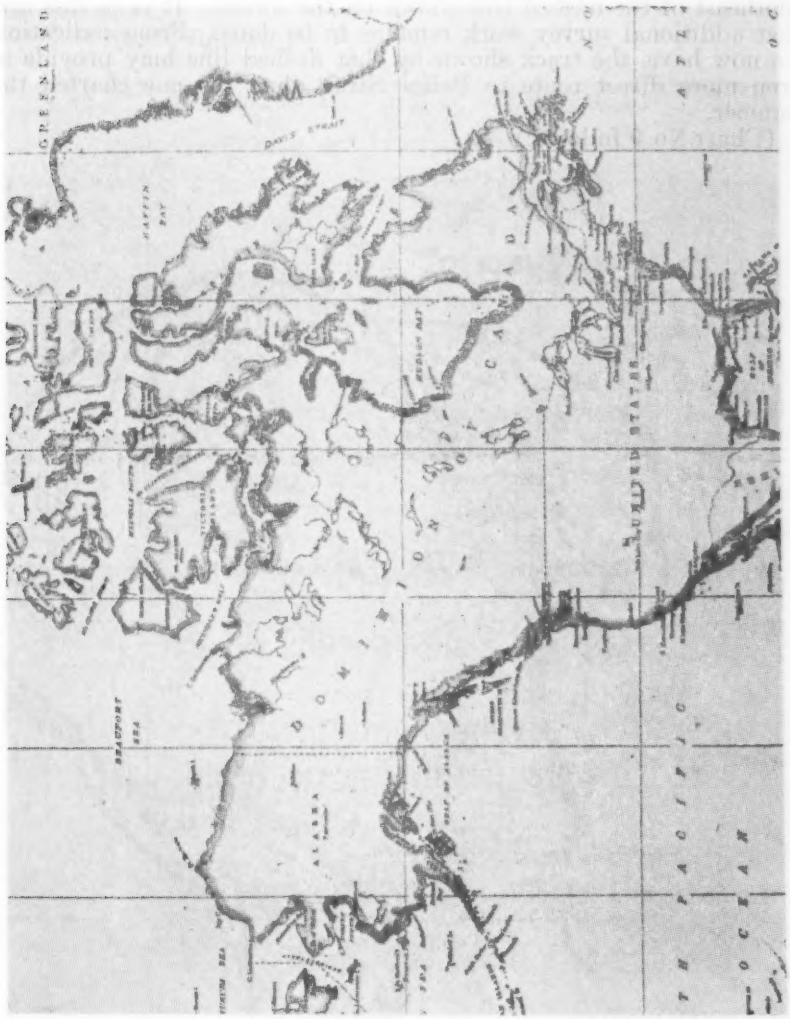
(Chart No. 7 follows:)



Admiral WILL. Military sealift in 1957 covered primarily the same areas as during the 2 previous years, with 1 major exception. The Alaskan stations from the Aleutian chain northward to Cape Lisburne, that is, the Mona Lisa sites, were resupplied, not by military forces under MSTS, but by commercial operators using the through bill-of-lading concept. This, then, became the second major military area in the Arctic to be resupplied independently of military shipping.

Active efforts were commenced in 1956 to determine the most probable route for a deepwater link between the western and eastern areas. Intensive chart study was continued and many hours of aerial photo reconnaissance were flown in the area of Bellot Strait. The information developed that year was processed and a decision to attempt a passage with survey ships and an icebreaker was included in planning for 1957.

(Chart No. 8 follows:)



Admiral WILL. A quick look at this Arctic map shows great expanses of water that would normally indicate little or no existing problems to planning and completing a voyage from the Atlantic to the Pacific through these regions.

(See chart No. 7.)

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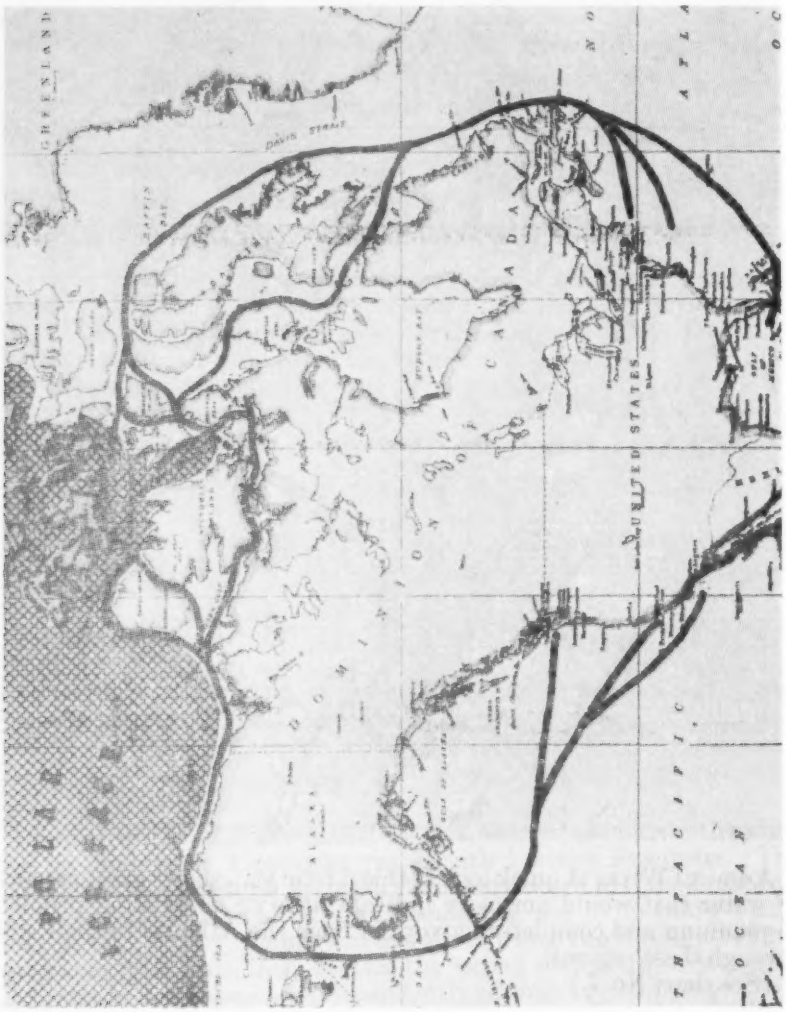
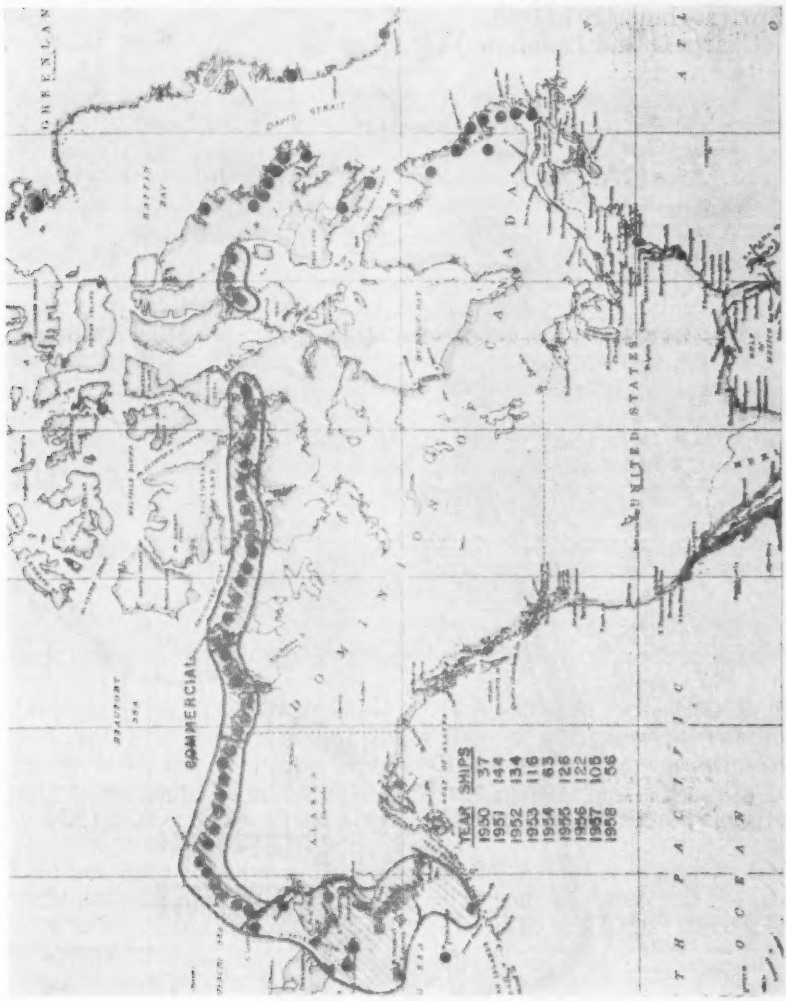
Admiral WILL. In 1957 we formed a task group of the three Coast Guard survey ships which were part of the DEW line sealift forces in the west, together with the Canadian icebreaker *Labrador*, one of the ships of our eastern DEW line force, and assigned them the task of developing an escape route through Bellot Strait to the eastward. As a result of the very fine survey job they did, under extremely adverse ice weather conditions, we now have a charted deepwater passage between the Pacific and Atlantic. The minimum depth found along the entire route was 36 feet, in the Simpson Strait area, just southeast of the dashed line shown on the screen. It is in this area that additional survey work remains to be done. From indications we now have, the track shown by that dashed line may provide an even more direct route to Bellot Strait than the one charted this summer.

(Chart No. 9 follows:)



Admiral WILL. From both Canadian and United States ship surveys, we now know that the depth of water in much of this area is sufficient for transit by deep-draft ships. The track lines plotted here are those of ships which have confirmed the existence of adequate depths. The northern tracks around Banks Island and through Viscount Melville Sound are exclusively by heavy icebreaker. The southern tracks skirting the polar pack along the Alaskan shore into central Canada and then northward to Peel Sound-Bellot Strait regions are those of the MSTS resupply forces associated with DEW line operations.

(Chart No. 10 follows:)

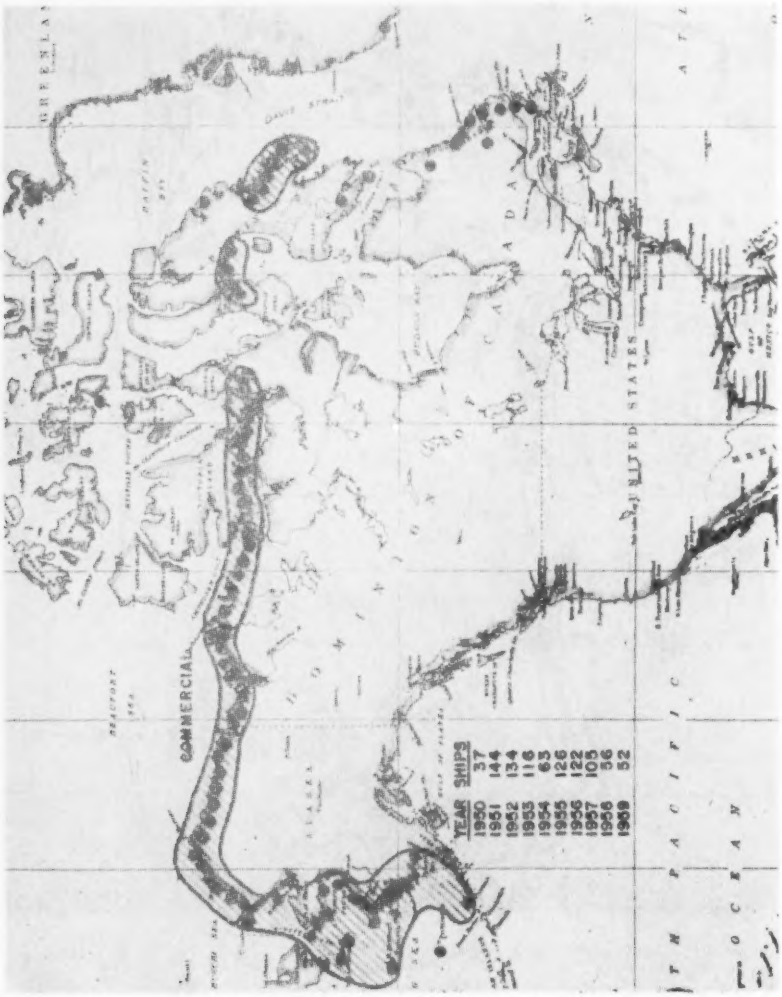


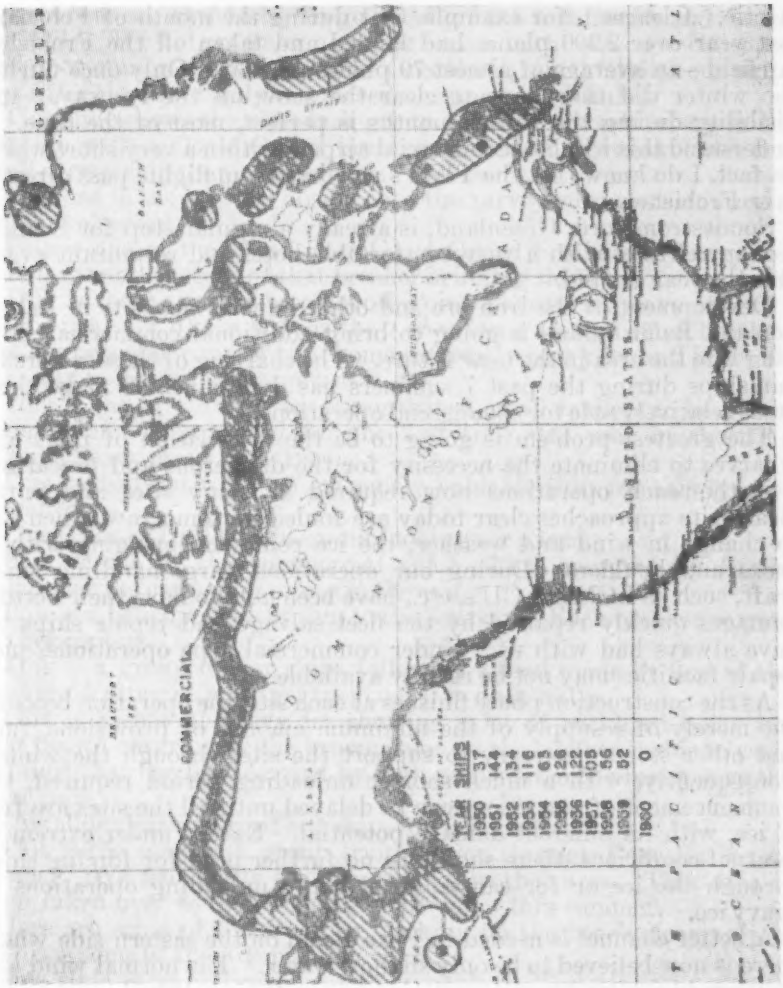
Admiral WILL. The planned 1958 Arctic program as shown by this chart reflects a tremendous expansion of the commercial resupply concept. Contracts have been signed which will extend the present commercial operation of the Mona Lisa sites from Cape Lisburne around Point Barrow to the eastern boundary of Alaska at Barter Island. From there the entire Canadian DEW line, except for the East Baffin Island sites, becomes a commercial sealift responsibility.

The hatched areas on the chart indicate the areas being taken care of this coming year by commercial operators. This expands the original commercially served sites at the mouth of the MacKenzie eastward to and including the Foxe Basin sites.

As I just said, a large part of the Arctic resupply will be provided by private industry in 1958.

(Charts 11 and 12 follow:)





Admiral WILL. In 1959, it is perfectly possible that the East Baffin Island sector of the DEW line could become a commercial venture. And, by 1960, the majority, if not all, of the military routine resupply needs could be accomplished by the private maritime industry with MSTS, the Navy, Coast Guard, Army, and Air Force standing by to assist when conditions require it.

I do not want to leave a discussion of the Arctic area and its commercial potentialities without passing on to you some personal observations I've made in the course of several trips to the Arctic during the past 2 years.

I might interject here that I made 2 trips each in 1951, 1952, and 1953.

While visiting Frobisher Bay this past summer, I got my first idea of just how important that particular site is to air traffic through the

Arctic. I learned, for example, that during the month of February last year over 2,200 planes had landed and taken off the Frobisher Airfield—an average of almost 79 planes per day. Only once during the winter did they have to clear the snow off the runways; and visibility during the winter months is perfect, most of the time. I understand this will be a commercial airport within a very short while. In fact, I do know that the TWA's new jetstream flights pass directly over Frobisher.

Sondestromfjord, Greenland, is already a regular stop for Scandinavian Airlines with a very comfortable hotel and restaurant available the year around.

Development of the iron ore and other mineral deposits in Labrador and Baffin Island is going to bring additional commercial shipping into the area in the near future. The charting of these waters by our ships during the past 7 summers has done much to make these areas relatively safe for commercial operations.

The greatest problem is going to be the installation of piers and wharves to eliminate the necessity for the dangerous and precarious over-the-beach operations now required at many sites and ports. Beach site approaches clear today are fouled up tomorrow, when due to change in wind and weather, the ice comes in, bringing with it rocks and boulders. During our operations, cargo-handling small craft, such as LCM's, LCU's, etc., have been able to have their bottom damages quickly repaired by the fleet salvage and repair ships we have always had with us. Under commercial type operations, such repair facilities may not be readily available.

As the construction phase finishes at each site, the operation becomes one merely of resupply of the minimum amount of provisions, fuel, and other stores necessary to support the sites through the winter. Consequently, with a much shorter unloading period required, the commencement of operations can be delayed until all the sites are free of ice, with its inherent damage potential. Except under extremely unusual conditions, there should be no further need for forcing ships through the ice or for carrying out cargo unloading operations in heavy ice.

A better channel is needed in Foxe Basin on the eastern side where there is now believed to be only shallow water. The normal wind and weather has a tendency to pile ice up on the westward side in the known deepwater part of the basin.

Oil discharge pipelines are badly needed in Goose Bay—Sondestromfjord—and Frobisher Bay—to enable the direct discharge of T–2 type and larger tankers without the use of smaller tankers to shuttle the product ashore.

This gradual phasing out of the MSTS/Army cargo-handling team partnership and the bringing in of private industry as soon as it has the capability, and conditions warrant, is another example of our reluctance to use Government ships and facilities where private industry can do the job.

Gentlemen, I ask your indulgence for a few minutes longer in order to show you some color slides. By these slides, I hope to give you an idea of just how tough Arctic conditions can make ship operations.

This slide is a scene taken in 1951 and shows the first of our ships en route to Thule. At that time we did not have the benefit of the heli-

copters that we have today to go ahead of the task forces and search out leads. We did not know also that earlier in the season a wide open lead opens up on the west coast of Greenland, which allows our ships now after the 1st of July to proceed unescorted to Thule.

This slide shows the same task group, showing a good iceberg in the distance with a Coast Guard breaker headed in to break loose this small survey ship that is beset in ice.

This one is the breaker nosing into the survey ship to turn around and shake her out.

This is one of the *Wind* class Coast Guard breakers in heavy ice.

This is another scene of that breaker bringing ships out.

This is the Navy's icebreaker off Point Barrow in heavy ice.

This is a shot of the bow of the *Labrador*, a Coast Guard breaker, that has been chewing away at some extremely heavy ice and is breaking away to take another crack at it.

This is the first of our ice strengthened small tankers to be put in commission. It was used for the first time this year in shuttling through heavy ice in Foxe Basin.

This turned out to be an extremely valuable ship for this type of operation.

This is one of the helicopters out looking for a lead.

This is one of the commercial GAA ships operated by States Marine for the cargo operations in the east.

This is a helicopter returning to the breaker. Each breaker carried two helicopters.

This is a group of our ships following a lead made by one of the breakers in attempting to get them out into open water.

This is a shot of heavy ice showing a lot of rockhard polar ice. That brown covering or the brown color on the surface is due to sand and dust that has been carried by high winds from the beach over the polar pack.

This slide shows more of our ships up in Foxe Basin.

This is the same task group trying to get through Foxe Basin this summer. We had really tough going up in that area. That area is being taken over by a commercial operation this summer.

Here are some of the frogmen working on the beach-clearing job.

This is some of their demolition work.

This slide is an indication of the trouble we sometimes have with ice on the beach in getting our LST's and small craft in for discharging.

This is another shot of the same beach site.

This is the Mission *Los Angeles* in Foxe Basin. She has a good sized hole in her bow and that is the ship's force doing a repair job.

This one is the same operation.

This is one of our LST's listed over in the ice to enable repair work to be done on the bottom.

This is an idea of the size of some of these bergs that you run into in the Atlantic. There are no bergs in the Pacific since we have no active glaciers in that area.

This is a scene in the Thule section of the Atlantic showing the icebergs and the extreme rugged nature of the terrain.

This is a glacier just north of Thule. These bergs are, as we say, caving off of those glaciers about one big one about every 15 minutes.

This is some of the wildlife in the Arctic, one of the original inhabitants.

Here he is getting his food from the garbage from one of the breakers.

This is one of the Victory ships in heavy ice and fog.

This is a task force heading up through Foxe Basin.

This is also a scene from Foxe Basin with the LST's in the foreground.

This is the *West Wind* in the Foxe Basin leading the Victory ship *Crane* out to the discharging site.

This is an icebreaker bringing an LST out into open water.

This is another shot of the task group in Foxe Basin.

This is the *Labrador* approaching Bellot Strait for the initial survey.

This is an aerial view of Bellot Strait from the western side.

This is another view of Bellot Strait, this time from the eastern side.

This is heavy ice off one of the sites with the breaker trying to work its way into the beach.

Here we have the three Coast Guard ships, that were to form the survey group and go through Bellot Strait, beset in heavy ice in the Amundsen Gulf. We had grave fears for their safety for some time. They really got caught and they were under heavy pressure ice.

This is the *Storis* on the right and *Spar* on the left. The other one is out of range of the picture.

This is another scene in the same area.

This is the *Storis* approaching the *Spar*. You will note that the *Spar* is trying to rock herself loose from that terrific grip the ice has on the hull by means of concrete weights hoisted out over the side on booms.

Here is the *Spar* and the *Storis* together. Note the list on the *Spar*. She had about a 14° list. You can see her propellers from the *Storis*. There is a terrific amount of pressure on the hull. The ice has a tendency to squeeze the ship up out of the water.

There they were using demolition charges in an attempt to break loose.

This is what happened to one of our tankers, the T–2, whose radar failed to detect a big berg.

This is a T–1 tanker in Frobisher. That ship has been operating in good shape and we turned her, with two other T–1's, over to the Canadians to use in their resupply this year. I title that picture "The MSTS Goes Everywhere on the Sea, in the Land, and in the Air."

That concludes my statement, Mr. Chairman.

The CHAIRMAN. Mr. Tollefson.

Mr. TOLLEFSON. How many icebreakers did you use up in the Arctic?

Admiral WILL. We normally use eight divided between the Atlantic and the Pacific, depending on the extent of the work. There are 5 Navy breakers and 5 Coast Guard breakers. We have had as many as 5 on one coast and 3 on the other, but recently we have been using 4 on each coast.

Mr. TOLLEFSON. Do they perform satisfactorily?

Admiral WILL. Extremely satisfactorily. We also made great use of the Canadian breaker, the *Labrador*, which is very experienced in that Arctic area.

Mr. TOLLEFSON. I have never been aboard one of those breakers. Do they carry anything besides their own fuel? Do they cary cargo?

Admiral WILL. No; they don't carry cargo fuel as such, but they carry enough fuel to do them during the season and they could make fuel available if need be to help out.

Mr. TOLLEFSON. Do you know whether any of them have operated in the Antarctic?

Admiral WILL. Oh, yes; they operate in the Antarctic. The *Glacier* is down there every year, and I would have to ask the Coast Guard, and perhaps Dr. Siple, which other ones they use.

Mr. TOLLEFSON. You are not familiar with their operations?

Admiral WILL. No.

Mr. TOLLEFSON. What is the length of what you call the season?

Admiral WILL. In the Atlantic we usually start into Goose Bay, which is the first of our major cargo movement, around the 1st of June. We start moving up into the Thule area around the 1st of July and we try to schedule our operations so that the last ship leaves Thule not later than the 30th of September. We could probably under some conditions, depending on the year, work later than that. We might also find a very severe winter chasing us out of there earlier. We have to be on the alert continually, but getting around the end of September we always keep a breaker standing by and we feel that we could get out later if necessary. This last year we had one of the new ice-strenghtened cargo ships, delivered in October. We tried to send her up with a breaker into Thule as a shakedown and christen her in the ice and they got 15 miles from Thule and the breaker said she didn't want to get wintered in up there either so the two of them came back, but that was well into November.

Mr. TOLLEFSON. I get the impression that winter is always up there, but when the winter months come is it possible for vessels to operate up there at all?

Admiral WILL. I don't believe it would be after the heavy ice sets in and the very low temperatures come on. The ice just gets too heavy. I think the Coast Guard is better able to speak to that, but I know that our people, in considering we would want to take on the job of surface resupply of *Alert*, worried not only about a breaker being caught in the ice, but beset in the ice and then carried with the rotating polar pack, and as somebody said, you would probably get the breaker back in 3 years.

I did not finish the period in the west, in the Pacific. We have not been able to get around Barrow before the 28th of July, although the *Mona Lisa* resupply does start back early in May and the latter part of April down around the Aleutians chain.

Mr. TOLLEFSON. The icebreakers carry enough fuel to take care of their needs for the season's operations.

Of course your experience with the icebreakers has always taken place during what we might call peacetime.

Admiral WILL. That is true, sir.

Mr. TOLLEFSON. I am wondering what you think are the advantages of an atomic icebreaker operating up there as against the conven-

tional type, particularly during, say, an emergency that might come on?

Admiral WILL. Mr. Tollefson, I am not an icebreaker expert. I have never had duty on an icebreaker. I would much rather have the Coast Guard speak to that.

The CHAIRMAN. Let me interrupt at this point just a minute. So as to have a continuity in these hearings, the staff prepared a brochure, you might term it, and sent it to each member asking that they go over it in advance, showing how we have endeavored to work out the progress of this hearing. I take it that Admiral Will is here today to show the responsibility charged to MSTS to supply the area and to point out the difficulties you have in supply and what your responsibility is there and, as the hearings progress, we have various witnesses to give testimony with respect to the conventional breaker and what may be expected from a nuclear breaker—if it is advantageous, and if the Coast Guard should keep abreast of the times and advance with science and engineering, or if the Coast Guard is merely going to stay in the rear and be an old-time organization and all other branches of the service advance in this nuclear age. That is the way we have tried to set these hearings up, so as time goes on we will have expert witnesses here to answer this type of question.

As the Admiral has said, he is not qualified to go into that field. Then we would have you available, Admiral, as we proceed with the various witnesses to come back and answer questions that may develop and may not be filled out completely by the succeeding witnesses.

Admiral WILL. I would be very happy to remain. In fact, I am very interested in remaining.

The CHAIRMAN. It is the responsibility of MSTS to fulfill the mission that has been assigned to you and you have shown on the screen the difficulty and problems you have, so the questions here would be with respect to what you have said and the slides that you have displayed.

Admiral WILL. Yes, sir.

Mr. TOLLEFSON. As I understand the things you have said, the icebreakers carry their own fuel, but they are in no sense a supply ship for any installation or any other ship.

Admiral WILL. However, they can be used and have been used to carry stores and supplies into places where you could not get cargo-carrying ships and small craft. We have a number of those sites up in the Atlantic Arctic where the breaker does take aboard supplies, dry stores, and fuel in drums to resupply certain ice-bound areas.

Mr. TOLLEFSON. As a general proposition their function is to break the ice or break the way for supply ships to follow?

Admiral WILL. Normally, or to open up a channel and take in supplies that would allow them to winter through the period. We had several instances of that here this last winter when they had a terrific cold spell in the Newfoundland area. We had to get a tanker into St. Johns and we also had to break a channel into I believe a place called Cold River where they had been icebound.

Mr. TOLLEFSON. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Robeson.

Mr. ROBESON. I know the chairman is right. We can't always keep asking you questions when we have other witnesses. I understand that you have icebreakers with your fleet operations under your command, is that right?

Admiral WILL. We borrow those icebreakers and they are assigned to our operational control by the fleet or by the Coast Guard whenever we ask for them, and we couldn't operate without them.

Mr. ROBESON. Of those you use a good many ships, apparently, which are converted ships rather than built originally as icebreakers. Is that right?

Admiral WILL. No. What I mentioned was an ice-strengthened cargo ship and an ice-strengthened tanker that we have just completed building for our operations in the Arctic, but they are merely fitted to work in heavy ice where we couldn't use a thin-skinned tanker or cargo ship.

Mr. ROBESON. Then I understand there is a need for modern icebreakers.

Admiral WILL. There is great need for modern icebreakers; yes, sir.

Mr. ROBESON. My understanding is that most of the icebreakers are rather old. You haven't many new ones; have you?

Admiral WILL. I think they date back to around 1930, but again I would rather have the Coast Guard answer to the age of those ships.

Mr. ROBESON. However, you support the proposition of new and modern icebreakers?

Admiral WILL. I would like to see some modern icebreakers, yes, sir, with modern equipment. I know for one thing the *Labrador* is in many instances better equipped for survey work in the ice than some of our breakers.

Mr. ROBESON. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Allen.

Mr. ALLEN. Admiral Will, this chart gets me a little confused as to distances in as much as it is a chart which we are familiar with, but if you look at the other chart up there, there seems to be a spot right down the pole.

How much of the area within the Arctic Circle do our operations cover?

Admiral WILL. We go up above the Arctic Circle clear up to as far north as Thule in Greenland along the very north coast of Canada clear over to Point Barrow in Alaska.

Mr. ALLEN. Is that about 180° longitude?

Admiral WILL. I think it would be somewhat less than 180°. It might be 160°.

Mr. ALLEN. It would be between one-third and one-half then of the area involved?

Admiral WILL. Yes, sir.

Mr. ALLEN. Are there any other operations in the same area of ships of other flags?

Admiral WILL. Not in the Arctic.

Mr. ALLEN. You do not see any similar operations, I take it?

Admiral WILL. There are some Danish operations along the western Greenland coast, down south of Sondestromfjord.

Mr. ALLEN. Turning to the *Labrador*, is it a heavier ship than our icebreaker?

Admiral WILL. No; I believe it is the same as the *Wind* class and there again I would have to ask the Coast Guard. I understand it is. I think the *Mackinaw* of the Coast Guard and the *Glacier* of the Navy are the largest of the icebreakers and the most modern.

Mr. ALLEN. With respect to our group of ships—I think there are 10 available—are they relatively of a class?

Admiral WILL. The majority of them I think are pretty much of a class, and then again I would like the Coast Guard to answer those details.

Mr. ALLEN. I was just trying to find out whether from your experience you had better experience with one type over another.

Admiral WILL. No; they all seem to do an outstanding job. We have no criticism of the breakers themselves.

The CHAIRMAN. Mrs. Sullivan?

Mrs. SULLIVAN. No question, Mr. Chairman.

The CHAIRMAN. Mr. Thompson.

Mr. THOMPSON. I would like to ask one question.

Admiral, most of the bases you serve are for the purpose of this DEW line operation, is that correct?

Admiral WILL. Either the DEW line or the Pinetree line, as they call it, and then of course, the major bases such as Thule.

Mr. THOMPSON. However, our great interest would not be in the commercial aspect so much as the security?

Admiral WILL. That is up to the present where our interest has been.

Mr. THOMPSON. In that connection have we ever observed the operations, say, of the Russians in their area in the Arctic?

Admiral WILL. I don't believe so.

Mr. THOMPSON. You do not know whether they have similar operations and icebreaker problems?

Admiral WILL. They have similar operations and to a much greater extent commercially than we do in attmpting to keep a route open along the north coast of Siberia, bringing ships from the area of the Cold River over into Vladivostok and they have considerably greater commercial operations in the area than we do.

Mr. THOMPSON. I just wondered if we had ever been able to observe whether or not they made more advances in the techniques of operating icebreakers and other ships in icebound areas.

Admiral WILL. I know of none, but there again, I would imagine the Coast Guard would have that operation.

Mr. THOMPSON. That is all. Thank you, Admiral.

The CHAIRMAN. Mr. Pelly.

Mr. PELLY. Admiral Will, I noted with interest your testimony with regard to transferring the military supply operations to commercial ships. Would that not increase the need for breakers, as you call them?

In other words, the DEW line supply ships, you send them as an integrated and one great supply fleet. Would not the commercial suppliers be more apt to operate independently and require more broadly the services of icebreakers?

Admiral WILL. Certainly, they are going to have the support of breakers if the going was tough, but, as I tried to point out, much of the need that we have for breakers is the fact that because of the large amount of material that we were taking in we had to force the season.

We had to go in there and use breakers to open up areas, whereas we would expect the commercial operators would be able to wait until later in the season and conditions would be more favorable, and there-

fore, they would not have as great a need for the breakers, but if things get tough, the breakers have to be available to help them out.

Mr. PELLY. Will not the individual commercial operators contract for their services and therefore, be independent rather than an overall coordinated supply operation?

Admiral WILL. There again, Mr. Pelly, I do not know just what the Coast Guard commitments are for these breakers and how much work they have to spread them over.

Mr. PELLY. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Rivers.

Mr. RIVERS. Admiral Will, during the war we transferred certain breakers to the Soviets.

Admiral WILL. Yes, sir.

Mr. RIVERS. I do not know what the number was. A part of them, if not all of them, were finally returned. To whom did they go when they were returned? The Navy?

Admiral WILL. I believe they were Navy breakers.

Mr. RIVERS. What happened to those breakers?

Admiral WILL. They are back in service again, as far as I know.

Mr. RIVERS. Under whose command?

Admiral WILL. They are the fleet breakers. The fleet has command of all the icebreakers. We simply borrow them.

Mr. RIVERS. And the fleet assigns them?

Admiral WILL. Yes, the fleet assigns them at our request.

Mr. RIVERS. Does the fleet have any new icebreakers?

Admiral WILL. The *Glacier* is the latest one.

Mr. RIVERS. How late is that?

Admiral WILL. It is about 2 years old, 1955, sir.

Mr. RIVERS. Is that later than anything possessed by the Coast Guard?

Admiral WILL. Yes, sir; I believe it is.

Mr. RIVERS. The possession by the Coast Guard of new icebreakers in its overall mission could not be in competition as you could see it, with anything possessed by the fleet, could it?

Admiral WILL. I could not see any competition there, no, sir, because they have different responsibilities.

Mr. RIVERS. Entirely different. Therefore, it follows that the Coast Guard being brought up to date would not be inconsistent with the welfare of the fleet.

Admiral WILL. I could not see where there would be any conflict.

Mr. RIVERS. Regardless of the category, the denomination, the structure, the makeup, the propulsion, or anything involved in the ship in question, if, in its wisdom the Congress decided to give the Coast Guard a nuclear icebreaker, that would inure to the advantage of the entire service, would it not?

Admiral WILL. I should think so.

Mr. RIVERS. I think if anybody knows about them, you would because of the mission that you have, and I think I know something about your mission. You could certainly know because you have been involved with the DEW line and have been up there at Thule, which is 600 miles south of the North Pole and way down there. The only people on whom you can rely firsthand to bring them to you is the Coast Guard.

Admiral WILL. We would certainly benefit by modern ships to replace those 15 or 20 years old.

Mr. RIVERS. Of course. There is no reason to impute that there would be competition, would there?

Admiral WILL. I cannot see any.

Mr. RIVERS. Thank you.

The CHAIRMAN. Mr. Gross.

Mr. GROSS. Admiral, there is one thing that is not quite clear in my mind. Is it proposed to integrate the use of commercial ships with MSTS vessels, or are you going to employ private carriers exclusively?

Admiral WILL. We did each year go out and invite bids on private shipping to assist us in the Arctic operations. We have had very little response because of the insurance problems and there are a number of other reasons. But when I speak of commercial operations, those operations are not integrated with the MSTS. There is a situation where the Army and the Air Force have gone out and contracted with commercial carriers to pick up their cargo load and deliver it to the site on a through bill of lading concept.

For example, the Mona Lisa sites were supplied by a group of three companies last year who picked up the cargo in the Seattle area, loaded it on their own ships, delivered it over the beach to the sites and even stored it for them.

This year the Alaska Barge Line, Bullock, has contracted to take care of the sites from Cape Lisberne around Point Barrow to Barter Island. MSTS will carry as far as Dutch Harbor. Then Bullock will load that cargo in his own barges, tow that up there and deliver it to the sites, but there is not an integrated operation there as such.

This is a completely contracted for job by commercial interests.

Mr. GROSS. But private carriers, as just shown in the movies, were operating with your vessels, were they not?

Admiral WILL. Those are ships under charter or ships that maritime made available to us under a general agency agreement.

Mr. GROSS. There are no privately operated icebreakers?

Admiral WILL. No, sir.

Mr. GROSS. Except perhaps in Great Lakes—or are there any on the Great Lakes?

Admiral WILL. I do not believe there are any.

Mr. GROSS. Thank you, sir.

The CHAIRMAN. Mr. Bartlett.

Mr. BARTLETT. Admiral, would you agree with me that it is factually correct, going back to the Siberian side, that historically the Russians have made much more use of the Arctic Ocean and sealanes than we have on our side?

Admiral WILL. I think there is no doubt about that because it has been a matter of their economy with them in getting their cargo ships through from the eastern to the western side across the north of Siberia.

Our development has come because of the establishment of the DEW line and these radar sites.

Mr. BARTLETT. And before then in the old days you had a few whalers going up there and later an occasional commercial ship maybe once a year.

Admiral WILL. Yes, sir; about that.

Mr. BARTLETT. Is it your opinion that interest in shipping to the Arctic that started with the construction of the detection systems up there is likely to be maintained by our country from now on in one way or another?

Admiral WILL. I think there will be a great increase in that area. Just how much our country will get into it or just what will be Canadian development, I wouldn't be able to say, but there is a new interest there in the minerals and the material that is available in the Arctic.

Mr. BARTLETT. Thank you.

Mr. ALLEN. Mr. Chairman, may I ask one question?

The CHAIRMAN. Yes, sir.

Mr. ALLEN. Admiral, if MSTS pulls out of this operation, leaving it a commercial venture, will the icebreakers of the Navy be as available to the commercial people as they have been to you?

Admiral WILL. I think that most of that would be done by the Coast Guard. If they got in trouble and there wasn't a Coast Guard breaker available, I don't doubt but what the Navy would come forward and help them out.

Mr. ALLEN. Would it be true then, that in planning your operation you had the possibility of 10 breakers available, but in planning the commercial operation they should plan only on the 5 of the Coast Guard?

Admiral WILL. That is true; yes, sir.

Mr. ALLEN. Thank you.

The CHAIRMAN. Mr. Curtin?

Mr. CURTIN. No questions.

The CHAIRMAN. Mr. Glenn?

Mr. GLENN. No questions.

The CHAIRMAN. The counsel has some questions.

Mr. DREWRY. Admiral Will, I have just one question.

In discussing the situation as it has developed since 1951 you showed how there was the initial stage and then gradually a building up in a period during which, as you say, you had to rush the season because of the great construction work that had to be done.

Now, we have come to a point where insofar as DEW line is concerned it would appear to be at the moment primarily a resupply job which because of the smaller quantity of material required for that purpose can be moved in and out during the open season. However, I wonder if we can think of that open season as really being dependable in itself for even the near future military needs up there.

I am thinking in particular about a story in the New York Times the other day that there is at present a proposal to build several new bases in the far north for antimissile missions. I think the figure that was mentioned was $195 million——

Admiral WILL. $189 million.

Mr. DREWRY. For construction alone and it would run to a quarter of a billion before they are through.

Would that bring the need for a further push in construction in the season to get those bases?

Admiral WILL. Yes, because there again, you would probably have a large construction project with all the heavy equipment and

all the building materials, the radar towers, and the extremely heavy material.

It would involve a lot of shipping and with still the same short season to get in, so it would be again a case of having to force that season in order to insure yourself that you are going to get that material landed before it freezes up.

Mr. DREWRY. In other words, right now things are developing so that we cannot assume that the season itself will be sufficient to meet our requirements up there?

Admiral WILL. We always have the unpredictable weather up there, too, that can cut that season down. I have heard statements where in Foxe Basin, where we had such a terrific time last year, we were 3 weeks late in getting that cargo in, and then only after we went up there and forced the people to drag those ships through the ice and take a chance on serious damage, did we get the cargo landed.

The ice never did go out of Foxe Basin. The low temperatures, we have heard, that have existed up there so far this winter, have given us an indication that these people may have a terrifficly tough time in trying to get commercial shipping through that ice this next summer.

We may be in a spot where we are going to have to go in and bail them out.

Mr. DREWRY. That is all, Mr. Chairman.

The CHAIRMAN. At this point, Admiral Will, will you contribute for the record from your own thinking, what motivated the Soviet Government to construct the nuclear icebreaker?

Admiral WILL. I think it is a matter of developing a modern ship, one that they could have countless uses for, support of their economy in the area north of Siberia, and their very, very great interest in the development of that northern sea route.

The CHAIRMAN. From your great experience in shipping in all areas, would you say they have a more acute necessity for such a ship than the United States and Canada have?

Admiral WILL. I would not be able to say that they do have a more acute necessity.

The CHAIRMAN. We have then, an equal requirement for such a ship to maintain progress in icebreaking facilities and knowledge and ability as they?

Admiral WILL. I would say that we have a great deal to gain and I think we would greatly benefit by such.

The CHAIRMAN. Thank you very much, Admiral.

Admiral WILL. Thank you, sir.

The CHAIRMAN. You have made a splendid witness and I think the committee is appreciative of the slides you showed here so as to give us a firsthand look at just what is taking place.

Admiral WILL. Thank you, Mr. Chairman. It has been a pleasure for me.

The CHAIRMAN. The next witness is Dr. Reed, of the Geological Survey, Department of Interior.

Dr. Reed?

STATEMENT OF DR. JOHN CALVIN REED, GEOLOGIST, STAFF COORDINATOR AND ARCTIC EXPERT, UNITED STATES GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

Dr. REED. Mr. Chairman and members of the committee, I am glad to be here this morning to discuss with you a few Arctic matters and especially I would like to discuss a little bit about Arctic research. Perhaps I should identify myself.

My name is John C. Reed. I am on the immediate staff of the Director of the Geological Survey in the Department of the Interior. Through my Geological Survey responsibilities I have been engaged in Alaskan matters, largely having to do with mapping and mineral resources, for a little more than 28 years.

Because of those responsibilities I have become interested in Arctic affairs in general and thus have become involved in some of the Arctic interests of such other organizations as the Office of Naval Research, the Arctic Institute of North America, the International Geophysical Year, the Office of Naval Petroleum Reserves, and others.

I should make it plain that I am in no wise competent to discuss the specific provisions of H. R. 9196. Those provisions are far out of my field, but I hope that some of the comments that I may have regarding Arctic research will be useful to this committee in considering that particular legislation.

The United States has long been interested in the Arctic areas. Much of the early exploration in the far North has been by Americans. This interest was, of course, stimulated when we acquired Alaska in 1867.

With modern developments, however, in equipment, transportation, and communications, the Arctic is not the closed area that it used to be and the requirement for modern knowledge of the Arctic under this concept is increasing and urgent.

This can be simplified, I think, by saying that we now realize in our thinking that the U. S. S. R. does not lie either to the east or to the west of North America. It lies to the north of North America. There is a sizable research program under United States auspices in the Arctic at the present time.

When I say "Arctic" in this connection, I mean Arctic North America and by North America I mean Alaska, Canada, and Greenland. The total program, I suspect, is larger than it ever has been in the past and is certainly more diverse.

This total program is carried out under a great many different authorities. Some of these authorities, for example, are the civilian agencies of the United States Government, like my own bureau, the Geological Survey in the Interior Department. I might also mention such organizations as the Weather Bureau in the Department of Commerce, many of the bureaus in the Department of Agriculture and so on.

In addition to these research efforts by civilian bureaus in the United States Government, there is the research work going on under the auspices of various universities and also under such institutions as the Smithsonian Institution and the private organizations such as the Arctic Institute of North America, and a good many others.

Much of this work by universities and private institutions is on a contract basis, again with various Government agencies. Most, how-

ever, of the research effort in the North American Arctic at the present time is done by or for the military services.

Presumably this research effort represents some sort of a strategic or defense requirement. The programs cover many of the scientific disciplines. In fact under one or another of the military services I expect that most of the scientific segments of activity are represented somewhere in the far north at the present time.

Mr. GROSS. May I interrupt there, Mr. Chairman?

What do you mean by "scientific disciplines"?

Dr. REED. I mean a segment of science such as oceanography or geology.

Mr. GROSS. Thank you, sir.

Dr. REED. The basis for the military interest in the north presumably is the lack or the limitations of basic information about the north which in turn, would be useful to the military in its activities.

Generally, it is understood, I believe, that the current Russian research effort in the north is far greater than the United States effort. There are many indications of this. It is a little hard to be precise in giving a general statement of that kind.

I believe, however, that it is probably correct. There was last summer an ad hoc group formed under the joint auspices of the Office of Naval Research and the Arctic Institute of North America that reviewed Arctic research of North America from Greenland on one side to Alaska on the other.

It was the considered opinion of that group on its return last fall, that the status of Arctic research so far as the United States is concerned is woefully inadequate. Further, the programs that are underway and planned, even if carried out, would be far too small to satisfy our real requirements.

I might just mention that this particular little group study of Arctic research involved visiting on the ground Fort Churchill in Canada, Thule in Greenland, and straight across the Arctic basin to Point Barrow in North Alaska and down to Fairbanks. I had the privilege of being on that trip. I believe also that the report of that group has been called to the attention of this committee.

Mr. Counsel, did you want to say something about that at this point?

Mr. DREWRY. Mr. Chairman, we were able to get a supply of this report in sufficient quantities for the members of the committee and they will be distributed today.

The CHAIRMAN. You may proceed.

Dr. REED. Thank you, sir.

I would like to mention some of the research projects that are now underway in the Arctic under North American auspices. It would be impossible, of course, to try to be comprehensive about this because the numbers would be too great. It would seem to me that the thing you might want would be a fair sampling of the scale and the scope and the type of some of the projects that are underway as well as perhaps a word or two about some of the deficiencies.

We have had, for example, for a number of years, the flights of the Air Force which periodically have gone from Eielson Air Force Base east of Fairbanks in Alaska to the North Pole and return, observing the ice and, of course, the changes of the sea ice, making observations on meteorology, on the upper atmosphere, and on other items of scientific interest.

The Office of Naval Research has supported since, I believe, about 1944, at Point Barrow, a facility called the Arctic Research Laboratory. At the present time, the Arctic Research Laboratory is operated under contract with the Office of Naval Research by the University of Alaska.

The scientific program that is going on there is a small one, but it has been rather carefully planned and is broad in both biological and physical sciences. The emphasis there has been on environmental studies and much of that which has been found out has already been applicable and it is anticipated that much more of application will come from the research at the Arctic Research Laboratory.

At Thule, for example, there has been substantial research and development by both the Corps of Engineers and the Transportation Corps of the Army in living under Arctic conditions and in movement both over and through the ice of the Greenland Ice Cap.

I believe, also, that most of you must be familiar with the cruise of the *Nautilus* last summer, and its voyage for many hundreds of miles under the Arctic ice which demonstrated beyond any doubt the actual capability for operations under the polar ice by a nuclear-powered submarine.

Now, let me mention some of the deficiencies. To some of us who have been concerned with these matters for a long time, it seems that some of the more glaring deficiencies are in the knowledge of oceanography of the Arctic areas. This is a large part of the Arctic area, as you can tell by a glance at the chart, and we really know very little about it.

In early days there was not much need for really comprehensive information about the Arctic Ocean. Now, there is. Let us look at some of the reasons. Intercontinental air routes, with modern equipment and modern communications, are perfectly feasible. In fact, there are commercial airlines flying over the Arctic at the present time.

Also, there is the operation of nuclear-powered submarines, which I have already mentioned. We need to know a lot more about the nature and the character, the changes and the shape of the Arctic Basin, and this points up, incidentally, the reason why the International Geophysical Year organization has two floating stations on the Arctic ice now.

One of those stations, station A, is about 800 miles almost due north of Point Barrow and that is on the sea ice. The second one is T–3, or Fletcher's Ice Island, which is several hundred miles northwest of the Canadian island, Ellesmere Island.

Perhaps I could go just a little bit further into demonstrating how oceanographic information might be useful in increasing our capability in the north.

Let us consider flying over the Arctic ice. There must be considered not only the low temperatures, the wind, the unpredictability of the weather, but remembering the earth is a planet, the polar area is one where there are great disturbances of cosmic-ray impact, of earth magnetism, of the aurora belt, and all of the factors that get into upper atmosphere problems and are critical in the development and use of electronic equipment of all kinds, including communications equipment.

Let us get down on the ice. We know from the experience of the Russians on the polar ice and from the somewhat more limited experi-

ence of the United States on the IGY stations that it is entirely feasible to use the natural ice platforms for certain purposes, although of course, they do move. We need to know a lot more about the distribution, the movement, the stability of the ice, the different characteristics of different kinds of ice, how it might be improved in order to make more permanent facilities feasible, and so on.

Then, we have the underice navigation where there is no possibility of using communications coming in from the outside. The navigation has to be by entirely different methods. This points up the need for a much greater knowledge of the bottom of the Arctic Ocean so there is a possibility of navigating by topography, information on the currents, the salinity, the temperature, and all the other factors of oceanography.

These are the things that now limit operations in the Arctic.

In closing, I would just like to make a few comments about the mineral resources of the Arctic. This matter has come up once or twice in the previous testimony.

Generally, I think it is apparent that mineral deposits in the Arctic are less economic than are mineral deposits at lower latitudes. You know that the mining and transportation of mineral resources depend on balancing cost against return.

Costs in the Arctic are high. Transportation is costly, recovery costs are high. Thus, equivalent deposits are less economical in the far north. The deposits therefore, to be developed must be either larger or richer or contain materials that are in especially great demand.

The mineral resources of the North American Arctic are only partially known. We do know that some deposits have been able to meet the type of competition that I have just outlined and are either producing or are being developed at the present time, such as the very large iron ore deposits in Labrador.

Although we do not have much comprehensive knowledge of the mineral resources of the North American Arctic, we do know something of the general geologic environments. We know the general geological picture and we know in turn, what these environments may mean in terms of likelihood of mineral deposits.

The general geology is such that we expect there are in the Arctic many more mineral deposits than we now have knowledge of. We need a more comprehensive inventory.

Finally, just one brief word, because this may come into our discussion later on, about the matter of mineral deposits that we may now or may later require for use in the north. Let me point out that if that situation ever arises the economic disadvantage becomes an economic advantage because it would thus be unnecessary to bring in resources at high cost from the outside.

I have in mind, for example, the Umiat oilfield that was discovered in the oil exploration program of the Office of Naval Petroleum Reserves in northern Alaska a few years ago. That oil field was considered not developable at the time it was discovered because of the cost of bringing it out.

That particular oilfield contains perhaps 75 million barrels of oil. It is very high in the kerosene or jet fuel factor. If we should require that kind of fuel in the Arctic the economic situation of the Umiat oilfield might be precisely the reverse of what it is now.

That completes my statement, Mr. Chairman. I will be glad to answer questions.

The CHAIRMAN. Mrs. Sullivan?

Mrs. SULLIVAN. The only thing I wanted to ask the doctor is about these floating islands that he talked about in the Arctic Ocean. What is their function?

Dr. REED. The islands are used as an occupiable place where we can have a facility to observe over a period of time the various types of information that we want to obtain in the north.

For example, we plan to occupy floating station A for a period of almost 2 years, summer and winter. During that interval, the station floats around a large segment of the Arctic Ocean. As it moves, water depths to the bottom are taken, auroral observations are made, and various characteristics of the sea water are observed. The result will be a knowledge of the scientific background of that part of the Arctic Basin.

This requires a long occupation in more or less one place.

Mrs. SULLIVAN. How would that be manned? Would someone stay on there for any appreciable length of time?

Dr. REED. Yes; that is the way they are being manned. Those two stations, just for your information, are actually operated by the United States Air Force. Station A, far to the north of Point Barrow, is operated from Alaska. Station B, the ice island, is operated from Thule with repetitive flights.

There are airfields on the ice at each one of these stations. The scientific personnel in the various disciplines in some projects are Air Force personnel carrying on Air Force research, or IGY personnel carrying on IGY research, or university personnel carrying on under contract a piece of IGY or military research.

This is all coordinated and planned by the International Geophysical Year Arctic Committee.

Mrs. SULLIVAN. So the occupants who were assigned the duty on this particular floating station would be there for a certain length of time to acquire information and then as this station would move around they become obsolete after a time?

Dr. REED. No. The present plan is to simply abandon those stations at the end of this calendar year.

Mrs. SULLIVAN. So there will not be any other floating stations, then?

Dr. REED. No; not currently planned. Perhaps I gave you a wrong impression, also. A single individual will not be 2 years on that station. Individuals can be replaced from time to time because of air support.

Mrs. SULLIVAN. The project would be for approximately a 2-year duration?

Dr. REED. Yes, that is right.

Mrs. SULLIVAN. Would those floating stations on that particular section of the ocean be able to discover anything about the depth of the basin?

Dr. REED. Oh, indeed, yes, they certainly do.

Mrs. SULLIVAN. It is difficult for me to ask intelligent questions about this as I must use my imagination as to how this particular service functions. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Tollefson? Mr. Allen?

Mr. ALLEN. Yes, sir.

Does the entire icepack float with no land projecting above the sea there?

Dr. REED. In that main part of the Artic Ocean that is true. It is simply ocean with floating ice on it and in a general way there are two kinds of floating ice. There is sea ice. This is frozen seawater and it may have been frozen and melted a number of times. The ice islands are believed to be broken off from the shelf ice on the northwest side of Ellesmere Island and dropped into the Arctic Ocean and are drifting around in it. A half-dozen or more have been discovered. These are large blocks to be measured in miles instead of being a few feet thick or a few tens of feet thick and, therefore, are much more stable platforms than are chunks of sea ice.

Mr. ALLEN. I do not have too much knowledge of international law or custom, but do you know whether any nation can claim a relatively stable area on a piece of floating ice?

Dr. REED. No, sir, I do not. Remember that that stable area does not stay in the same place. It keeps moving, too.

Mr. ALLEN. Then it is quite probable that as far as that whole northern area is concerned, it would be similar to any other ocean and beyond claim under at least the customary laws of any nation?

Dr. REED. The Soviets have several of these floating stations, also, at the present time. One of them, North Pole 7, is very close to the North Pole right now.

Mr. ALLEN. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Clark?

Mr. CLARK. No, sir.

The CHAIRMAN. Mr. Mailliard?

Mr. MAILLIARD. No questions.

The CHAIRMAN. Mr. Pelly?

Mr. PELLY. Do I understand that there is no land as far as the polar cap goes? There are no peaks?

Dr. REED. No.

Mr. PELLY. As I understand the thought has been advanced that our nuclear submarines could hide under the polar ice and come out from that protection and use any open spots to launch missiles against the heart of the Soviet Union if there were any such hostilities. Then they could move around under that entire polar pack, could they? Is it solid in places?

Dr. REED. If we knew enough about the shape of the bottom, there would be some means of navigating and knowing where you were.

Mr. PELLY. Is it deep?

Dr. REED. Yes, and some of it is very deep, ocean depths. There are some presumed mountain ranges under there. We know very little about it.

Mr. PELLY. In other words, you are advancing the theory that we should chart this ocean if we could?

Dr. REED. Yes, indeed, I certainly am.

Mr. PELLY. Would not an icebreaker be useful in any such operation?

Dr. REED. As I say, I am not an expert on icebreakers.

Mr. PELLY. The scientific stations that we have there now are supplied entirely by air, as I understand.

Dr. REED. Yes, and this does raise some problems. For example, take the station north of Point Barrow, it has been drifting to the northwest ever since it was occupied and when it was put in there they had to go pretty far north to get an area of ice that seemed to be solid enough that it is likely to hold together during the summer, which it did fortunately. It kept moving northwest and the airfield wasn't very long and it began to get beyond the range of a C–47 aircraft, which was being used to supply it and the field was not big enough for a larger aircraft with a longer range. This sort of thing becomes a real problem.

Mr. PELLY. Is there anything that could have been supplied during certain seasons of the year at all by taking it in by ship?

Dr. REED. By surface ship?

Mr. PELLY. Surface ship; yes, sir.

Dr. REED. It is problematical; I suppose with a big enough icebreaker you probably could have gotten to it. It would depend on certain conditions. What might happen this year might not happen next year. We do not know enough about the movement of that ice and maybe it is at the edge of the icepack one year and hundreds of miles within the pack the next year. We simply do not know.

Mr. PELLY. In the Soviet Union, can ships go from the Pacific to the Atlantic north of Siberia?

Dr. REED. I, again, am not an expert in this particular sort of thing. I am sure there are other people who are much more so. Generally, I believe they travel from the east to the west along the north side of Asia and I believe also that generally this takes more than one season, but of this I am not really informed.

Mr. PELLY. They have a great commercial interest in ports on the Atlantic side, do they not?

Mr. REED. Yes.

Mr. PELLY. That is all, Mr. Chairman.

The CHAIRMAN. You said the Russian ships travel from east to west and generally it takes more than one season. Did you mean to convey that ships stay ice-locked there the whole year?

Dr. REED. This has been my impression. I also want to make it plain, however, that I am not an expert in this field.

The CHAIRMAN. You just made the statement. I just asked the question: Do they stay ice-locked there during that year and proceed on the next season?

Dr. REED. That is my understanding; yes, sir.

The CHAIRMAN. Would that have any connection with the desire of Russia to improve its ice-breaking facilities?

Dr. REED. I would infer so.

The CHAIRMAN. Did you ever collaborate with your contemporaries in your field from the Soviet Union?

Dr. REED. Yes. We have at the policy-making level, but so far as I know not at the field-work level.

The CHAIRMAN. At the scientific level?

Dr. REED. And at the planning stage; yes, we have.

The CHAIRMAN. Are all your stations established there by air?

Dr. REED. Yes, sir.

The CHAIRMAN. The two stations?

Dr. REED. The two floating stations are established by air. There are other stations on land in the Arctic.

The CHAIRMAN. I mean these two stations you mentioned you established by air?

Dr. REED. Yes, sir.

The CHAIRMAN. I understand you to say there would be an advantage if you could get surface transportation to there?

Dr. REED. Yes, sir.

The CHAIRMAN. Mr. Bartlett.

Mr. BARTLETT. I want to commend the witness for a very helpful statement.

Dr. Reed, in addition to your Government duties, are you not also a member of the board of directors of the Arctic Institute of North America?

Dr. REED. Yes, I am, Mr. Bartlett.

Mr. BARTLETT. Mr. Chairman, I should like to convey to the committee a personal opinion that no man is better equipped than Dr. Reed to give this group or any other, precise and factual information about the Arctic. If it were his habit to go about the Arctic on skis, or snowshoes or over it in a broken-down, single-motor plane and thereafter publish a book with a thrilling account of his experiences with the customary exaggerations in such accounts, which he has not done, then he would be universally recognized, I am sure, for the Arctice expert he really is.

I think that no man has made a greater contribution to our store of Arctic knowledge than Dr. Reed.

Thank you.

Mr. ALLEN. May I ask one more question?

The CHAIRMAN. Yes.

Mr. ALLEN. That comment on navigation that you made makes me ask what happens to a traditional or conventional type compass up in that area, either magnetic or gyroscopic.

Dr. REED. A magnetized compass is completely unreliable in many Arctic areas. I do not know about the gyroscopic compass.

Mr. ALLEN. What systems of navigation are available for observation of celestial bodies?

Dr. REED. Celestial navigation, dead reckoning, the shape of the bottom of the ocean if you know enough about it.

Mr. ALLEN. I suppose you get some help from direction finders, radio, and just surface triangulation of a kind?

Dr. REED. Oh, yes; I hope I have made it plain that I am not an Arctic navigator in any sense of a ship operator.

The CHAIRMAN. Counsel has some questions.

Mr. DREWRY. In that carrying out of research, of course, you want to do it over the whole area. Would there be advantage to researching with the aid of a vessel that would enable you to stay in the area much longer than the open season?

Dr. REED. It would certainly be scientifically advantageous if it were possible to get to places in the Arctic more readily and to stay there longer. This is very true. Two big problems of Arctic operations, in almost all fields, are transportation and communications.

Mr. DREWRY. In the past, isn't it true that our early operations in the ice areas in our own Arctic were conducted either by the Coast

Guard or combined collaboration with the Coast Guard and Geodetic Survey or other services?

Dr. REED. I do not think I can really answer that.

Mr. DREWRY. You go back to about 1928 or so.

Dr. REED. I go back to about 1930 in the north; yes.

Mr. DREWRY. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Curtin?

Mr. CURTIN. Dr. Reed, this question may be just a little far afield, but you have said with respect to the minerals discovered up there that their value depends on a lot of special factors.

Taking that into consideration, have you any prognosis as to the future of the oil discovery that was made on the Kenai Peninsula?

Dr. REED. In the first place, the Kenai oil discovery is not in the Arctic. It is much farther south. There has only been publicly announced the finding of oil in one well. That well has been publicly announced as being about a 900-barrel-a-day well. If this, in fact, indicates a substantial accumulation of oil from one hole—you don't know how big the field may be—then it would indeed be a big economic factor in the future of the Territory of Alaska.

Mr. CURTIN. However, that, up to this point, is somewhat uncertain?

Dr. REED. This happens to be in my field. The indications are good. The proof is not yet clear.

Mr. CURTIN. Thank you. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Glenn?

Mr. GLENN. I have no questions.

The CHAIRMAN. Thank you very much, Doctor.

We have our old friend, Albert Colbert, as our next witness.

The CHAIRMAN. It has been suggested that the report of the Arctic Research Advisory Committee be inserted at this point in the record.

(The reports referred to follow:)

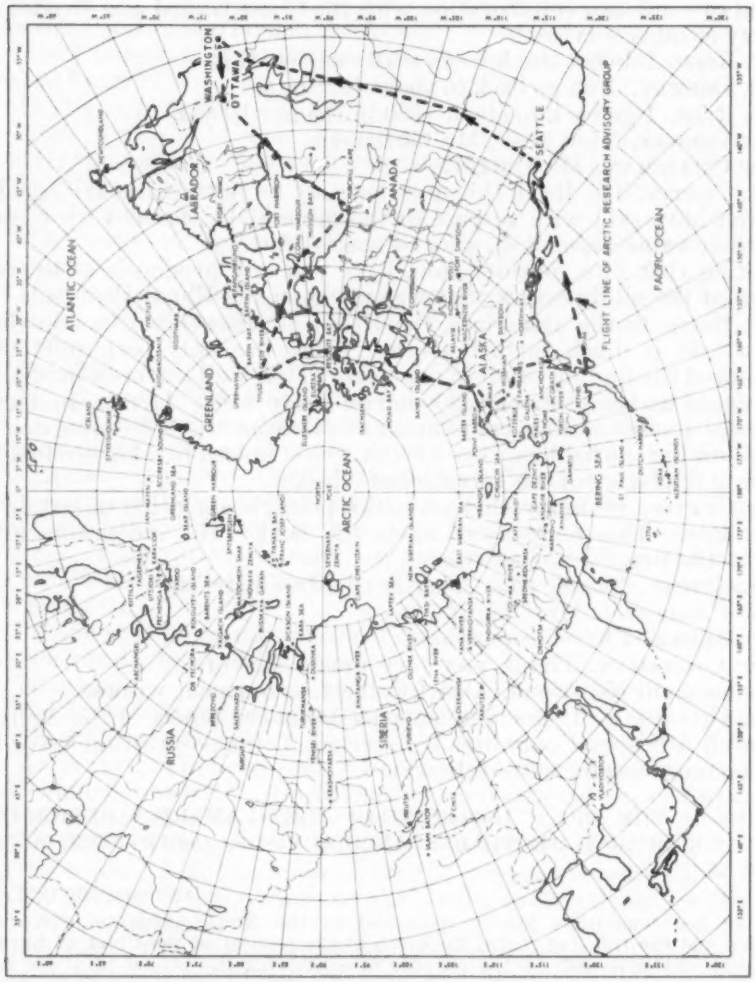
REPORT OF THE ARCTIC INSTITUTE OF NORTH AMERICA, OFFICE OF NAVAL RESEARCH, ARCTIC RESEARCH ADVISORY COMMITTEE, OCTOBER 25, 1957

OCTOBER 25, 1957.

An ad hoc committee, jointly sponsored by the Arctic Institute of North America and the Office of Naval Research at the request of the Chief of Naval Research, was convened for the purpose of examining the phases of arctic research which might have military significance. Since arctic research involves the total environment, and therefore a wide variety of scientific disciplines, it is of direct concern to all military services of this country and Canada. For this reason membership of the committee included, in addition to representatives of AINA and the Navy, representatives of the Department of Defense, Army, Air Force, and the Canadian Joint Staff (Washington).

The committee visited Fort Churchill, Thule, Point Barrow, Fairbanks, Kodiak, and Seattle during the period September 23–October 4 for the purpose of on-the-ground evaluation of northern research facilities and review of arctic research programs. It interviewed scientific and operational authorities of the Defense Research Board of Canada, Fort Churchill IGY rocket project; SAC IGY, and Transportation Arctic Group operating in or out of Thule, including Ice Island T–3; Arctic Research Laboratory and IGY operating in or out of Point Barrow, including drifting station A; University of Alaska, IGY, and Aeromedical Laboratory operating in or out of Fairbanks; Naval Air Station, Kodiak; and University of Washington, Seattle.

The conclusion reached is that the quality of arctic research being conducted ranges from high to low and its quantity is unacceptably small. We have seriously inadequate scientific information on the cold regions comprising the vital strategic area of the North Polar Basin. The Arctic's true military potential



can only be transformed to the dynamic by means of studies specifically oriented to the problem. A discussion of the factors leading to this conclusion is provided in appendix I, which deals with the importance of the high Arctic to North American defense, and 8 appendixes which deal with the studies required to implement strategy; research in the fields of ice; oceanography and bathymetry; geophysics; landforms; meteorology; biology, ecology, and human factors; communications, navigation, and detection; and logistics.

The concept that the Arctic is a barrier to an aggressor is no longer tenable—the Arctic is a highway to those who have the wit to use it. We cannot depend on superiority over the adversary in numbers, in physiological or mental toughness, or in heavy industry—the free world's only certain sword and shield is superiority in basic knowledge and spirit. Expanded Arctic research is essential so that we may extend our northern military frontier to the Soviet arctic littoral. Our eastern and western military frontiers abut the geographic borders of the Moscow-Peiping Axis, whereas a vacuum exists in the Arctic Ocean area due to our lack of capability in this region. Large-scale, intensive, and competent Arctic research and development, being pursued by the Soviets without fanfare, will permit filling of the vacuum. Unless we meet this challenge, we will invite a scientific Pearl Harbor. We cannot rely on Arctic research by

private enterprise since it has insufficient economic incentive to warrant rapid, large-scale expenditures of funds for scientific investigation of snow, ice, and related phenomena and for basic geophysical research on problems peculiar to the Arctic. Instead of past and presently planned financial starvation of fundamental and applied Arctic research, the volume of such research must be sharply increased. This increase should be immediate because of the years of lag between the obtaining of scientific data and their translation into operating capabilities.

The committee therefore strongly recommends:

1. A major increase in funds allocated to arctic research and development.
2. Establishment of an office of Assistant for Arctic Research under the Assistant Secretary of Defense for Research and Engineering for the purpose of formulating Arctic research policy, of assigning Arctic research responsibility to individual services and agencies, and of monitoring the resulting coordinated arctic research program.
3. An Arctic Research Advisory Board consisting of representatives of the Armed Forces and of the civilian scientific community, both governmental and private, to guide and serve the Office of Assistant for Arctic Research. An additional responsibility of the Board will be to insure the close and continuous contact between line officer, engineer, and scientist which must be maintained for prompt and effective exchange of ideas and knowledge.
4. Complete integration of the American and Canadian Arctic research effects.

PAUL QUENEAU, *Chairman*
(For the Committee).

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APPENDIX

I. IMPORTANCE OF THE HIGH ARCTIC TO NORTH AMERICAN DEFENSE

The Soviets have achieved parity with the United States in respect to weapons systems and long-range weapons-delivery systems. The question of relative vulnerability of the opposing industrial complexes and offensive forces thus assumes transcendent importance. At present, we cannot look to the future with optimism in this regard.

Less than 100 high-yield, thermonuclear weapons delivered on area targets which are the keys to our industrial might would destroy it, and the enemy is familiar with the geography of such targets. Less than 100 low-yield, atomic-fission weapons on the point targets presented by our bomber bases at home and abroad would cripple our air-striking capability, and the enemy has the coordinates of these targets. Furthermore, many of our bases located outside

of the Western Hemisphere in general, and in Europe in particular, are vulnerable to political action which can, and probably soon will, deny their usefulness. Our security is also adversely affected by the Kremlin's surprise capability—it can surreptitiously commit its striking forces to sudden aggressive action. Soviet industrial power and air-striking capability may be less vulnerable than our own because of our relative ignorance of the geography of their critical target areas and the coordinates of their bomber and long-range missile bases.

Discussion of the vulnerability of the U. S. S. R. to the air-striking capabilities of United States aircraft carriers, missile ships, and submarines as compared to our vulnerability to the air-striking capabilities of Soviet submarines is omitted on the arbitrary assumption of a standoff situation and, furthermore, such consideration is not within the province of this paper.

Geography canalizes the Soviet air-striking capability against the continental United States over the north polar desert, for reasons of distance and attack security. Russia's historic preeminence in cold regions research, development, and operations must be reckoned with in this connection. The Wehrmacht learned to its sorrow of the Red army's predilection, training, and equipment for winter warfare. Now, Soviet weapons-delivery systems deploy along thousands of miles of Arctic littoral in the Eastern Hemisphere: their numerous scientific parties work on the pack ice of the Arctic Ocean in both hemispheres; their submarines with underice capabilities in all likelihood explore the north and east coasts of Greenland; and their reconnaissance planes probe the high altitudes of the Western Hemisphere. We thus confront the enemy across the frozen vastness of the North. Unfortunately, we are far behind our natural northern military frontiers—the many military disadvantages of this situation are obvious.

Present national policy for the maintenance of world peace is based on deterring potential aggressors through fear of massive retaliation. The effectiveness of this policy is, of course, no better than the potential aggressors' estimate of our capability and of our intentions. If, on the one hand, serious deterioration in the military and political security of our bases in the Eastern Hemisphere continues, and if, on the other hand, we do not assume a military posture in depth in the high Arctic the Soviets will have strong political grounds for disbelieving the essential element of intent in our policy. We face a situation in which most of our offensive forces, our vital economic centers, and our homes will have the same geographic identity. In these circumstances, the human reluctance of our citizens to bear the full weight of a nuclear-weapons onslaught would be followed by further and unacceptable piecemeal expansion of the Soviet empire and of Chinese hegemony. Furthermore, if, through lack or slowness in prior planning and preparation for high Arctic operations, world political events oblige us to make large-scale withdrawal to the United States and southern Canada, the Soviets will be tempted to resort to an upside-down version of massive retaliation at a time and place of their own choosing, i. e., surprise attack through the polar skies by manned and unmanned weapon vehicles in self-defense.

We must make maximum use without delay of the immensity of Arctic space to push outposts northward as far forward as possible and capitalize on the resulting manifold military rewards. As one example, an IRBM with a 2,000-mile range becomes an ICBM if launched in the high Arctic—a great significance of this fact lies in the governing facets of missile design and delivery pertaining to cost and accuracy. Furthermore, such an IRBM is now in our arsenal, and an ICBM is not. American occupation of forward positions in the high Arctic will thus result in early and major augmentation of our offensive capability and, coincidentally, sharply diminish our hostages to counterbattery fire.

An American-Canadian buildup in the high Arctic would greatly increase the number and complexity of the problems facing our antagonist. The deployment of nuclear weapon-equipped, mobile, dispersed, small "mosquito" units in the high Arctic, employing all suitable delivery systems, would threaten the Soviets with a relatively invulnerable offensive force remote from our heartland and relatively close to their own offensive Arctic deployment. By thus taking advantage of the geographic realities which favor us, we can simultaneously threaten emasculation of the Soviet attack springboard, interdiction of their Arctic lines of communication, and grave injury to their industrial base. Conversely, the forward deployment of early-warning units in the high Arctic would decrease our reaction time to Soviet offensive action, improve our remote-air-battle capabilities, and thus decrease our vulnerability to attack from the north.

Science will permit our use of Greenland as an Arctic sword and shield—a mighty bastion of deterrent power essential to the NATO concept. Here the key element of geography is in our favor, since this island lies equidistant and athwart the great-circle routes between our heartland and that of the Soviets. Its 850,000 square miles of polar Sahara constitute a giant platform for weapons and weapons-delivery systems, including mobile long-range artillery, and for a far flung detection, tracking, and interception complex. A number of locations along the relatively snow- and ice-free littoral of Greenland north of 75° north latitude, such as Thule Air Force Base on the west coast and the Shannon Island area on the east coast, lend themselves to employment as central supply depots for the support of small, dispersed troop units and installations on the icecap or on gravel terraces or in the fiords of northern Greenland or on islands such as Ellesmere and its ice shelf and on natural or artificially reinforced floes of the polar permanent pack ice.

The troop units required for high Arctic operation will be small in size: mobility will be one of their key characteristics; they will be self-sufficent for an extended period; and automation and robots will be employed to the full extent feasible. Ground defense of our installations and lines of communication will be a responsibility of these units. The nexus of a few subterranean logistic centers and many decentralized offensive and defensive forward positions should support and be supported by surface transport, by aircraft, and by atomic-powered submarines with underice capabiilties. The security of these forward positions will depend partly on passive defense measures available to them based on small size, on dispersal, on concealment by digging in and camouflage, on the frequent atmospheric conditions of low visibility, on mobility, on deception, and on the absence of indigenous population. Our patrols must be prepared to encounter and evict intruders utilizing these same methods. The Soviets will, no doubt attempt small nomadic lodgments at strategic sites in this desolate region—such an attempt was made by the Nazis in World War II with much less compelling incentives than now spur our would-be undertakers.

An absolute prerequisite to our effective use of the high Arctic is harnessing of its environment. The Arctic's true military potential can only be transformed to the dynamic by means of studies specifically oriented to the problem. Modern technology will make possible military operations in the Far North—under the ice, on the ice, over the ice—previously inconceivable. However, more knowledge is required to permit military man to work with the cold rather than against it, and to do so in a practical and economic manner. The Arctic is friendly only to those who comply with its implacable laws.

The low ambient thermal regime of the Arctic permits conversion of the limitless local supply of water, liquid or solid, into an engineering material of tremendous value for a wide variety of construction purposes. Field studies in Greenland indicate a capability for the economic construction of a practical line of communications by snow cut-and-cover operations, including road, personnel, and storage facilities just below the surface of the icecap and of excellent, heavy-duty airstrips on the icecap by snow consolidation. Natural ice floes of the polar pack can be reinforced with steel and other materials and thickened with additional ice so as to convert them into floating "Texas Towers."

In conclusion, history records the legions annihilated by Hannibal after he surprised the Romans by crossing the snow-covered Alps with his elephants, suddenly invading Italy from the north. The French lost the battle of France after Hitler surprised them by crossing the rugged Ardennes with his tanks, suddenly outflanking the Maginot line. Due to the present meteoric velocity of technological progress, 1957 firepower is as superior to that of the 1940 German panzers as the latter were to the firepower mounted on the pre-Christian era Carthaginian war elephants. We must not be surprised if the Soviets suddenly cross the snow-covered, rugged Arctic with their modern engines of war.

II. ICE

This report discusses features, phenomena, and processes that are composed of ice or have to do directly with ice. Ice is subdivided, for convenience, into (1) land ice, (2) sea ice, (3) fresh-water ice, and (4) ground ice.

(1) Land ice is ice on the surface of the ground. This includes, principally, glaciers which in the Arctic may be roughly divided into two groups—icecaps and alpine or valley glaciers. In the icecap group, principally, are included the Greenland icecap and the ice of Ellesmere Island, which projects into the ocean as an ice shelf.

(2) Sea ice is ice on the surface of the sea, and includes frozen sea water and ice islands that have been broken off from the Ellesmere shelf and, perhaps, from other places around the Arctic Ocean.

(3) Fresh-water ice is ice that forms on lakes and rivers in the Arctic.

(4) Ground ice is ice within the crust of the earth, and is generally designated "permafrost." Permafrost, by definition, is a temperature phenomenon, and no ice is present unless water below its freezing point is present.

The widespread and abundant distribution of ice in each of the above categories in Arctic and subarctic North America, including Greenland, is so significant that ice must be considered a key factor in considering man's capability in the North.

Ice study, including glaciology, overlaps or impinges on other sciences and technologies such as geology, engineering, meteorology, and oceanography. There are relatively few facilities in the United States where ice, glaciers, or glaciology are studied systematically. Among those that are engaged in such work are SIPRE, ACAFEL, the Army's Vicksburg laboratory, the Bureau of Yards and Docks, the Office of Naval Research, and the Geological Survey. Work also is done by the Arctic Institute of North Amerca, the American Geographical Society, and some universtities.

Experience demonstrates the feasibility of using ice in the Arctic for military operations. A well directed research program will result in greatly increasing the feasibility of arctic operations involving ice. Strategy should include the development of much greater operational capabilities on, in, under, and with the use of the four categories of ice mentioned above. Involved in increased capabilities we visualize: (1) Deployment of offensive weapons systems for nuclear defense including bomber forces, fixed and mobile ballistic missile forces, and submarine forces; (2) Deployment of warning systems to protect nuclear offensive potential against surprise attack, namely, air warning, ballistic missile warning and submarine warning; (3) Active defense weapons systems for protection of arctic nuclear deterrent forces; and, (4) Development of increased feasibility of the employment of surface troops.

Land ice.—The feasibility of using land ice, principally the Greenland ice cap, has been demonstrated. More knowledge of the physics of ice, its modes of formation, and behavior under different conditions can increase the use of land ice as a surface over which to travel, as a construction material, and as a mass that man can penetrate by tunnel or otherwise. The Corps of Engineers has been experimenting with tunnels in the Greenland ice cap and with the use of such openings for storage, living, and other purposes. Experimentation is progressing by the Transportation Corps on how to handle the ice cap surface for movement over it. Much progress has been made by the Army in the excavation of trenches in the ice by the "cut and cover" techniques and the use of those trenches for travel, for storage, and for living. The limited use of valley glaciers for landing surfaces for small aircraft is increasingly recognized.

Sea ice.—Aircraft landing strips on sea ice have proven practical for even our largest planes. Such strips offer advantages in location and accessibility under adverse weather conditions.

Operation of icebreakers and unreinforced surface vessels on both sides of the Arctic has become routine, altough not devoid of problems. Operation of submarines in ice covered waters will soon be no novelty.

Numerous semipermanent installations on sea ice have been made by the Russians, more recently such installations have been accomplished by the United States. Warning or missile launching sites on sea ice must be considered as possibilities. The requirement for surface travel over sea ice and problems of storage on and in ice should not be overlooked.

Questions as to thickness, bearing strength, stability, transparency, roughness and surface features, areal extent, movement, deformation, disintegration, and acoustic properties of sea ice arise. If the proper techniques of measurement and prediction existed, these questions could be answered more or less routinely by the engineer or the forecaster. They do not exist and, therefore, must be developed from the body of scientific information collected in the field and from experiments designed to yield answers in the field and in the laboratories.

Certain areas require extensive oceanographic study in order to develop a basic understanding of sea ice movement, formation and disintegration. One such area of immediate significance to surface ships is the shipping lane from the Bering Sea along the north coast to Point Barrow. The Foxe Basin-Hudson Strait-Hudson Bay complex is another oceanographic system requiring intensive study.

An intensive observation program should be conducted on the Bering and Chukchi Seas throughout the year. The program should include:

(*a*) Heat exchange between atmosphere, water and sea ice;
(*b*) Heat transport by water currents;
(*c*) Movement of ice with wind and current;
(*d*) Ice coverage;
(*e*) Sea ice formation and disintegration; and
(*f*) The intrinsic physical-chemical properties of the sea ice.

In order to observe the Bering-Chukchi Sea system, it will be necessary to establish small observation stations along the principal current flow north to Point Barrow to monitor heat transport by water current and heat transfer between water, atmosphere and ice. One such station is presently in operation at Cape Prince of Wales which includes observation of water transport, weather, heat transfer by micrometeorological observations, and study of ice formation. An observation station is required at Point Hope, and preferably another between Point Hope and Point Barrow. A partial station is established at Point Barrow. In addition to the shore observation posts, icebreaker support is required throughout the year to carry out observations at sea. Observations are particularly required during fall and spring by an icebreaker following the formation-advance of sea ice during fall and the disintegration-retreat during spring.

The operational significance of the above lies in prediction of warm waterflow and of shipping conditions to Point Barrow. These studies would include the confluence of the Beaufort Sea westward flowing current and the Chukchi Sea northeastward coastal current. Study of the Barrow sea valley is of importance to submarines. It is essential that a small boat (e. g., Greenland cruiser) be stationed at Point Barrow capable of operating along the coast, occasionally in brash ice, with sufficient range to carry out necessary oceanographic observations.

A similar study is required between Point Barrow and the Amundsen Gulf as a basis for prediction of sea ice and the possibility of movement of ships along the north coast. The purpose is detailed information on ice and currents at particular shoreline features, needed by a task unit in passing that shoreline feature. The Mackenzie River is believed to exert a major influence on this eastern Beaufort Sea system. A joint United States-Canadian program should be formulated to conduct this study. Furthermore, the Amundsen Gulf is highly significant to submarine operations because of the reported permanence of open water throughout the year and the deepwater access of the area to the Beaufort Sea Basin.

To support these strictly observational programs, both laboratory studies and field studies of small sea ice-water systems should be made to establish validity of fundamental equations of heat transfer between ice, water, and atmosphere and the growth and disintegration of sea ice, in addition to the intrinsic physical properties of sea ice. One such system is believed to be the Port Clarence-Imuruk Basin complex at Teller, Alaska. It appears feasible to instrument this system for a measure of heat budget factors in order to determine the validity of heat exchange measurements and assumptions made in observations of the Arctic Ocean system or coastal systems.

A synoptic ice program has been carried out by the United States Navy Hydrographic Office for several years. However, this work has been primarily operational in nature, to assist in the establishment and resupply of DEW line sites. Much synoptic ice work remains to be done in understanding the formation, growth, modification, movement, and disintegration of sea ice.

The Bureau of Yards and Docks and the Air Force Cambridge Research Center have conducted work on the bearing strength of sea ice and other problems relating to the construction of air landing strips on sea ice. The Snow, Ice, and Permafrost Research Establishment (SIPRE), the United States Navy Hydrographic Office, and the Canadian Defense Research Board have been participants in some of this work. The Naval Electronics Laboratory has made some bearing strength and stress measurements. Thickness, temperature profiles and some heat conductivity tests are being made on ice floe station A and some work on sea ice has been done on Ice Island T-3. The Naval Electronics Laboratory has an ice-growing tank ready for testing which will supply the basic requirement for many laboratory engineering, chemical, and physical measurements on ice.

A second ice floe station should be established near 77° N., 150° W., to form, along with IGY Station A and Fletcher's Ice Island, a net from which motions of the ice pack can be studied. Periodic flights should be made between these

stations. If compatible with other United States interests, information on the ice cover on the part of the Arctic Ocean toward the U. S. S. R. should be obtained from the Soviets in exchange for information from United States investigations.

Projects are needed to increase our knowledge of factors controlling the bearing strength of ice, the compressional strength of ice, and the relationships between heat conductivity, temperature profiles, and ice growth. Little is known of the relationship between salinity, density, porosity, and grain size. What are the factors controlling electrical resistivity of sea ice? What are the acoustic properties of sea ice?

The ice growing facility of the NEL should be fully utilized. Possible subjects for investigation include:

(*a*) Ice growth and deterioration processes, including superstructure icing.

(*b*) Ice strength, and factors determining this.

(*c*) Temperature, salinity, and density structure of sea ice (including porosity, grain, and brine cell size).

(*d*) Heat and electrical conductivity of sea ice.

(*e*) Light transmission through sea ice.

(*f*) High frequency sound transmission in sea ice.

Fresh water ice.—The lakes and streams of the Arctic provide means of boat travel in summer and landing surfaces for aircraft on pontoons. In winter they are useful for surface travel with heavy equipment because the ice is generally smoother than the frozen, snow-covered tundra or sea ice. Such surfaces make good landing places for wheeled or ski-wheeled aircraft. Research in fresh water ice can lead to methods of thickening the frozen surface in winter in order to prolong its use in the spring or even to preserve the surface throughout the year.

Ground ice.—Ground ice has great implications relative to transportation, water supply, waste disposal, and foundation conditions. Substantial research has gone on in permafrost over the past 10 years or so and much has been learned. Much more remains to be learned about its thickness, distribution, and characteristics. Additional understanding of permafrost can be translated immediately into dollar savings and increased capability.

III. OCEANOGRAPHY—BATHYMETRY

A. Military concept

1. Submarine: Ten years ago, submarine experiments by the Pacific Fleet led to the concept of developing submarines for operating throughout the Arctic Ocean during all seasons. The recent cruise by U. S. S. *Nautilus* (SS(N)571) northeast of Greenland to 87° N. included 1,383 miles steaming under ice in the Central Arctic Basin, and thus has demonstrated the submarine capability immediately at hand in the Arctic Basin. To exploit this Arctic capability and fulfill the assigned missions (missile delivery, lifeguard, AEW, ASW), certain field research work must be accomplished, namely:

(*a*) Bathymetric survey of the Arctic Ocean and the Canadian Archipelago.

(*b*) Oceanographic study to provide current drift, and water structure for application to navigation, sonar propagation, and sea ice prediction.

(*c*) Ice coverage study, including distribution of thickness and size, particularly size and distribution of water openings.

(*d*) Study of sea icebreaking strength from underneath and the physical-chemical properties of sea ice with regard to thermal conductivity and formation on surfaced structures.

2. Surface ship: Surface operations require bathymetric survey of those passages in the Canadian Archipelago not yet completed and more complete coverage of Foxe Basin and Hudson Bay. Surface operations particularly require understanding and prediction of sea ice movement, coverage, and breakup.

B. Field research program

3. The 1952 *Redfish* operation in the Beaufort Sea pointed up the need for precise bathymetric soundings in the Beaufort area. Similarly, the long excursion under ice by *Nautilus* pointed out the need for precise bathymetry on the Atlantic side of the Arctic Ocean; its approaches and the central passage through the Canadian Archipelago are essential to arctic submarine operations. Precise

bottom charts offer the best passive method of fixing position to first approximation when cruising under ice, at least until a reliable inertial system is developed.

4. A large sector of the Chukchi and Beaufort Seas was surveyed by using electronic repeater stations (EPI) at known geodetic points ashore during 1951 through 1954. Similarly, systematic surveys must be made along the northern coasts of the Canadian Archipelago, and particularly Greenland, across the Greenland Sea northeast of Spitzbergen in order to delineate the Atlantic approaches to the Arctic Ocean. The U. S. S. R. has been very active the past 10 years in the Arctic Basin gathering bathymetric data by aircraft landings on the ice and by drifting stations. The United States Navy should gather these data in a shorter time and in the much more precise and meaningful form of continuous contours by submarine, the submarine surfacing at the end of each survey leg to fix position by electronic aid. These bathymetric surveys are the most essential field work in the immediate future. Oceanographic study of water masses and currents should be conducted concurrent with the bathymetric survey but kept secondary to bathymetry, the primary mission.

5. Much required survey work can and should be accomplished by icebreaker, reducing the size of areas that can only be accomplished by submarine. Areas essential to submarine operations and particularly suitable to survey by icebreaker are:

(*a*) Passages through the Canadian Archipelago, especially McClure Strait-Lancaster Sound, McClintock Channel, and similar passages;

(*b*) North passage from Baffin Bay to Lincoln Sea; and

(*c*) The broad sector north of Spitzbergen along edge of the polar pack.

The passages through the Canadian Archipelago should be evaluated both for transit of United States submarines and for defense points to deny access to U. S. S. R. submarines. The evaluation of side passages is particularly pertinent to defense points; for example, if the Lowther Islands appear feasible as a defense point against the McClure-Lancaster transit, can this point be circumvented through McClintock Channel or Wellington Channel.

6. To answer these questions requires precise bathymetric survey and determination of bottom type, sea ice conditions, current and oceanographic conditions in order to estimate effectiveness of any sonar barrier installation. Obviously the study of passages through the Canadian Archipelago falls directly under the scientific purview and sovereign responsibility of the Defense Research Board and the Royal Canadian Navy. Furthermore, it is fortunate and specifically noted that the Royal Canadian Navy has the best equipped vessel (H. M. C. S. *Labrador*) to conduct the necessary survey and oceanographic work. This vessel has the essential electronic equipment installed for precision survey and is the only stabilized icebreaker; hence, can conduct survey work in the open sea. The United States research groups should give careful consideration to how best they can contribute to this work with personnel, equipment, and additional icebreaker support. It is believed that the Joint Canadian-United States Beaufort Sea Expeditions, 1951–54, which were organized through the cooperative effort of 12 Canadian and United States scientific agencies, provide a desirable pattern for conduct of future cooperative effort.

7. Study of the oceanographic structure and circulation of water masses in the Central Arctic Basin should be continued from drifting ice stations. It is assumed that the oceanographic structure of the central basin is simple and stable, in contrast to the complexity of peripheral areas where mixing and melting-freezing occurs. A few drifting stations should, therefore, be able to contribute valuable long-term or seasonal observations which will directly supplement oceanographic observations made by submarine over large areas but perhaps in only one season. Of course, these drifting stations also measure the water depth, as well as such other observations as weather, sea ice, earth's gravity and magnetism.

8. Sonar: The effectiveness of sonar is highly dependent on oceanographic conditions. All desired improvements of sonars (range, resolution, recognition, etc.) so often expressed for conventional open-sea operations, are equally applicable to sea ice areas. Two sonar features are unique to any sea ice area: namely (*a*) active sonars must always work against a background of the many discrete targets of the ice overhead, and (*b*) the ambient noise level is much lower than that in any open sea area. Both features place a premium on high performance of passive sonars and reduction of any self-radiated sound. Any improvements in active sonars for open sea areas should equally apply to sea ice areas. Any

improvements in passive sonars will apply equally well to ice areas and probably will perform better under the much lower ambient noise level. No special development program is required for either passive or active sonars.

9. A topside sonar system for submarines is required in order to (*a*) evaluate the type, distribution, and thickness of the ice canopy; (*b*) make ascents into leads or brash ice, or (*c*) find thin, recent frozen sheet ice in leads during winter operations. Evaluation of the type of ice canopy, e. g., giant floes, small floes, or brash is required to decide in any particular area if speed should be reduced because probability of a lead, or small water patch, is sufficiently high to warrant search for the particular opening in which to surface. The topside sonar must then guide the ascent into the opening.

10. Oceanographic studies should provide the information necessary to estimate sonar conditions both for under ice navigation and for target detection. No sonar problems peculiarly different from low-latitude oceans are anticipated except for study of sound scattering and reflection coefficients of sea ice. Conventional sonar prediction techniques should be applicable to the Arctic Ocean but should be sample checked by sound transmission tests in selected areas whenever submarine-ship or two submarine teams are available for conducting the necessary measurements. These measurements should be designed to obtain reflection and scattering coefficients of sea ice and attenuation constants at various frequencies. The 1952 *Redfish* study at 1,000 cycles per second in the Beaufort Sea is an example of the type of work required at other frequencies and other sea ice-thermal conditions.

11. Biological oceanography must be considered an integral part of any basic study of the marine sciences. While this side of oceanography may not make as great nor as immediate a contribution to increased military capability, its importance to the overall interpretation and assessment of the Arctic marine environment must not be overlooked.

Certain biological programs are already underway and it is recommended that these efforts be continued and integrated into the overall program for the American Arctic. The following broad lines of investigation are recommended:

(*a*) Biological population in relation to water mass, oceanographic processes, sea ice, and seasonal cycles.

(*b*) Productivity in relation to water mass, oceanographic processes, sea ice, and seasonal cycles.

(*c*) Environmental adaptations of marine organism (osmoregulation and freezing).

(*d*) Sound scattering and noises.

(*e*) Analysis and assessment of arctic marine resources.

It is recommended that biological studies be carried out concurrently with one or a part of any marine investigation where physical measurements are made, whenever such studies do not conflict with the military research. For little additional effort a great gain in basic scientific knowledge can be expected.

IV. LAND FORMS

Land forms are interpreted broadly to include: (1) The development of land surfaces to their present forms, (2) the character of the land features, (3) the unconsolidated materials lying on and near the present land surfaces, and (4) the distribution and modes of occurrence of both surface and underground waters. Ice is excluded as far as practicable from consideration because that subject is adequately covered in the other appendices.

An essential field of Arctic research is the study of geological processes peculiar to Arctic environments. Generally these include: (1) Processes of disintegration of bedrocks and (2) processes of erosion, transportation, and deposition of rock materials released by disintegration.

In considering research requirements related to land forms as outlined above, prime importance is attached to geologic mapping of both the bedrocks and surficial deposits in the North. Knowledge of the character, distribution, and structure of Arctic bedrocks is incomplete. There is little information in this field especially in regard to Greenland and the Canadian Arctic Archipelago. Northern Alaskan bedrocks are reasonably well known and mapped. Some of the reasons for the need for Arctic bedrock mapping are mentioned below. Surficial materials are even less well known in the Arctic than are the bedrocks. These are the materials that must be considered and used in many Arctic operations such as road and runway construction.

Mineral resources should be appraised for both economic and military reasons. This is especially true of the fossil fuels. The presence in the Arctic of significant petroleum resources such as in the Umiat oilfield in northern Alaska may be very significant. Many places in the Arctic contain large, but generally low rank, coal resources that constitute a cheap source of energy. Even now, gas from the Barrow field is the energy supply for the Barrow facility of the Air Force.

Terrain analyses should be made of Arctic areas as a basis for site selection for transportation routes, facility sites, foundation conditions, and camouflage possibilities. This would involve the mapping and study of glacial features, terraces, flood plains, beaches, including raised beaches, and other land forms. This type of investigation is of special importance in essentially snow-free areas such as Peary Land.

Engineering geology should explore for use both bedrocks and surficial materials. Underground facilities in bedrock, of particular interest militarily, hold special possibilities in arctic areas because of protection both from the enemy and the weather, economic operation and maintenance, and good foundations.

Shore processes differ in some respects from their counterparts in more temperate areas. The sea handles arctic materials, the effect of ice shove must be considered, and the beaches are frozen for long periods. Operations and conditions that are involved include the possibility of the construction of docks, the stability or lack of stability of beach shapes, means of fixing terminal connections in the water for the pumping from barges or tankers of POL products rather than slow and expensive transfer to the beaches of drummed products.

Permafrost (permanently frozen ground) has received much attention already but it is not yet well understood, nor is its distribution and thickness known in many places. Permafrost is of signal importance relative to foundations, water supply, waste disposal, and transportation. The heat exchange principles that are a factor in the formation and preservation of permafrost and the effect of various types of terrain on permafrost both need more study.

Almost no research has been done in the Arctic on hydrology—including the special problems of surface and underground water and of its chemical quality. The arctic environment, including especially permafrost, has a profound effect on hydrologic conditions. Some of the importance of water in the North stems from the fact that permafrost underlies the ground and the surface waters are frozen for a part of the year. Closely related to hydrology are the northern problems of sewage disposal. Unfrozen zones that might be used as sources of ground water and perhaps as reservoirs into which to discharge sewage are known to exist below some lakes that are too deep to freeze to the bottom. This is because the floor of the lake never can have a temperature below freezing.

Good aerial photographs of much of the Arctic are available. Photogeology, the study of geology by photogrammetric methods, has unusual possibility in the Arctic because of the general lack of concealing trees and soil and the ease with which Arctic terrain types can be recognized and mapped. On the other hand, snow cover is a limiting factor.

All of the above underscore the need for much more intensive effort in the fields mentioned as a basis for an adequate and badly needed knowledge of a fundamental segment of the Arctic environment that must be gained for the most effective operations in the Arctic.

V. METEOROLOGY

The distribution of Arctic meteorological observing stations appears adequate for the preparation of the large-scale synoptic charts except over the Arctic Ocean Basin. However, it does not meet the requirements for studies of large-scale circulation within the Arctic Basin, nor for exact forecasting in that area. The only local research noted, outside of that being done at Churchill, was at T–3, Drifting Station A and the Arctic Research Laboratory at Point Barrow. The only firsthand view of this work was obtained at the latter station. Here the impression gained was that by a modest outlay for automatic recording gear the available, highly qualified personnel could be freed to carry on scientific work of a higher level.

The following recommendations are made for the extension of meteorological research in the Arctic:

1. That studies of appropriate items outlined below be undertaken at the Arctic Research Laboratory, on the polar pack ice or at DEW line sites:

A. Synoptic meteorology:
- (*a*) Wind and pressure regimes (general circulation studies)
- (*b*) Temperature (mass transport of energy, etc.)
- (*c*) Humidity
- (*d*) Precipitation, clouds, and weather
- (*e*) Radiation studies (large scale)—albedo measurements

B. Micrometeorology:
- (*a*) Low level temperature profiles
- (*b*) Low level wind profiles
- (*c*) Low level humidity profiles
- (*d*) Detailed radiation studies
- (*e*) Ice accretion studies

C. Atmospheric physics:
- (*a*) Atmospheric electricity studies
- (*b*) Cloud physics studies
- (*c*) Upper atmosphere density studies
- (*d*) Studies of aurora and airglow

D. Atmospheric chemistry:
- (*a*) Composition of the atmosphere at all levels
- (*b*) Ozone, carbon dioxide, and water vapor studies
- (*c*) Ion clouds at high atmosphere

2. That an Arctic Atlas be prepared from currently available data, and that a study of means of obtaining data for revision of this atlas be undertaken.

3. That increased emphasis be placed on the development of instrumentation for the Arctic.

4. That an attempt be made to standardize the meteorological instrumentation and observations in the Arctic.

5. That an exchange of information of NATO countries engaged in Arctic research be fostered.

6. That a suitable meteorological research facility be established at some Arctic location such as Point Barrow where families could be accommodated and year-round continuous studies could be made.

VI. GEOPHYSICS

A. General

Our fields of interest in arctic geophysical research include: (*a*) geomagnetism, (*b*) aurora-airglow, (*c*) ionosphere, (*d*) meteors, (*e*) cosmic rays, (*f*) radio astronomy, (*g*) radio propagation, (*h*) seismology, (*i*) radio noise, and (*j*) earth currents and earth potential. The following is a brief résumé of observations made by the committee in the course of its visits to the establishments noted below:

1. Fort Churchill: Studies in progress here at DRNL (Defense Research Northern Laboratory) include (*a*) through (*g*) of the above fields. Mr. Frank T. Davies, Assistant Chief Scientist DRB, reported that these studies were being vigorously pursued to the virtual exclusion of all other scientific research at this station. Reasons given were critical importance of this work in defense research and the cohesiveness of the program and type of investigators so as to yield an effective team. In general, it seems clear that the program at DRNL is progressing satisfactorily under capable direction. Moreover, it is in the main likely to be a continuing effort rather than depending on IGY support. With regard to the large IGY rocket program at Fort Churchill, we could make no attempt to evaluate the individual scientific programs conducted by various laboratories in the United States at this site. The faciilties and logistic support seem to be excellent.

2. Thule Airbase: The IGY-supported research programs at Thule are noteworthy for their automaticity. There are no scientists in continuous attendance and records are handled entirely by Army Signal Corps and Air Force personnel. Indications are that such an arrangement is not entirely satisfactory. Covered by the programs at Thule include (*a*), (*b*), (*c*), (*e*), (*h*), and (*i*) of the above fields. Standard automatic sweep frequency ionospheric equipment is in satisfactory operation. Back scatter observations on four frequencies are being made for Stanford University, but no indication has yet been made by them as to the adequacy of these observation. Here, as in some of the other work at Thule, closer communication and liaison between the scientists

and the field observers is needed to improve the morale of the observers and to obtain an effective team. Signal intensity measurements on two frequencies over a specified path are recorded continuously. Some changes are being made currently. The auroral spectrograph has been installed and is apparently operating satisfactorily. The all-sky camera has not yet arrived at Thule, where all is in readiness for its installation. The neutron counter is in satisfactory operation. The cosmic ray telescope is not operating satisfactorily. Records are being obtained from the seismograph operated for the United States Coast and Geodetic Survey although difficulty was observed in respect to stability of the galvanometer installation. Automatic records of noise on a number of frequencies are being obtained. The only question arising in connection with this program is the existence of means for distinguishing between noise and interference without audiomonitoring. Variometers provide useful magnetic records for correlation with auroral and ionospheric activity.

3. Ice Island T–3: While we were at Thule we talked with two scientific observers who had just come in from Ice Island T–3. They reported that morale was good there and that the IGY scientific program was proceeding in a satisfactory manner. The scientific studies include seismic and magnetic observations and studies with the all-sky camera. Some difficulties had been encountered with keeping an air strip in operation, but supplies had been dropped at frequent intervals.

4. Point Barrow: The investigations now being conducted at Point Barrow that lie in the above fields of interest are studies of aurora-airglow with an all-sky camera, employment of a wave transmitter for observations of auroral reflections and earth current studies in the University of Alaska program at the Arctic Research Laboratory of ONR and magnetic measurements at a separate magnetic laboratory between ARL and Barrow Village. The programs are proceeding in a satisfactory manner. They have learned how to install low resistance electrodes in the permafrost and tundra and are now obtaining good data in the lagoon.

5. Drifting Station A: While we were at Point Barrow, two of the scientific personnel from this floating ice station came into Barrow. They gave us a detailed and enthusiastic report of the station there. The scientific studies include seismic and magnetic observations and studies of aurora-airglow with the all-sky camera.

6. Fairbanks: The scientific studies that lie in the above fields of interest that are being conducted near Fairbanks are largely under the direction of the Geophysical Institute of the University of Alaska at College, Alaska. We got a favorable impression of the investigators and of the quality of their work—their potential for carrying out additional fundamental research looks very promising, but funds are needed to pursue it. The measurements by University of Alaska and others near Fairbanks include aurora-airglow studies, spectroscopic studies of the ozone layer and surface ozone measurements, a study of meteors, aurora, and the moon by radio methods, studies of the position and intensity of radio stars with an interferometer, transmission properties of the ionosphere, radio wave propagation, geomagnetic studies, magnetic measurements with a differential magnetograph, and studies of earth potential and earth currents. Simultaneous measurements of magnetic d and h and of earth potentials during auroral displays show that the disturbances in magnetism and potential are not parallel. Thus, earth potential studies provide an independent probe of ionosphere disturbances. This important work on earth potentials is being supported under a small grant from the National Science Foundation. The group at the Geophysical Institute of the University of Alaska believe that the geophysical program has been too heavily weighted toward applied research and that several very promising leads developed by pure research are not being followed owing to lack of funds. They cite specifically radio wave interaction techniques, shift in infrared spectrum and enhancement in ozone during aurora cycles which may have important implications in meteorology, and VLF propagation under arctic conditions with apparent variations in arrival angle of as much as 45° which should be investigated further.

B. Impediments to research

From our visit to the research facilities in the Arctic some major impediments to effective research were noted. There is an urgent need for higher priority and need of increased support from military authority for research programs. The major mission of SAC at Thule and that of the Alaskan Air Command at Fairbanks is not research. Any reesarch is supported only if planes or per-

sonnel can be spared on a noninterference basis. Despite the best efforts of the local military command, lack of priority, personnel, equipment, and funds create serious obstacles to effective research. When funds and personnel are cut as at present, already inadequate research support is bound to suffer further.

Another major impediment to effective research at any given installation is lack of scientific supervision of the program. For example, at Thule there is little or no scientific supervision of the program which is carried out by military personnel for scientists who are not present. With adequate scientific supervision at Thule, the personnel could operate more effectively and obtain more and better data. In contrast, at the ARL of ONR at Point Barrow the director, who is a competent scientist, integrates the whole scientific program and gets better teamwork among the scientists. The result is better data and a high morale. Similarly, at the Geophysical Institute of the University of Alaska there is adequate scientific direction and integration of the many different researches and personnel to produce an effective team and a high level accomplishment.

A third impediment to research is lack of proper liaison between the scientists and the technicians who make most of the measurements. We noted at Thule that several scientists had a program for measurements, but that some of these scientists seem reluctant to go up to Thule to set up and calibrate the complicated apparatus properly, and see that it was in good working order before turning it over to technicians for long-term data recording. Furthermore, even when the scientists had set up equipment personally and had it calibrated and in good working order, some of them did not maintain contact by mail with the observer who likes to know whether the data he is taking are satisfactory. Lack of such contact produces low morale and frustratiton.

C. Recommendations for future

The following recommendations are made in respect to research in our fields of interest as outlined above:

1. Adequate funds should be made available immediately to support basic studies in geophysics, particularly those suggested by the Arctic research scientists themselves.

2. The present two ice stations in the Arctic should be continued after the IGY and their scientific programs expanded. Additional ice stations should be established to carry out the oceanographic and sea-ice programs and geophysical measurements should be included at these stations.

3. A survey of all IGY programs in the field of geophysics should be made within the framework of a review of all North American geophysical research. Based on this information a long-term realistic program of basic and applied geophysical research should be prepared and executed.

VII. BIOLOGY, ECOLOGY, AND HUMAN FACTORS

Past research in the above fields, as carried on in the Arctic, has produced some outstanding results but has suffered somewhat from: (*a*) lack of coordination of effort among workers at different stations; (*b*) lack of information about related projects being carried out by other agencies; and by (*c*) the inability to promulgate an overall plan of research projects integrated into a well-rounded research program.

Research in biology, ecology, and on human factors is being carried out on a substantial scale at Point Barrow and at the Aeromedical Laboratory at Ladd Air Force Base. It is not being done at Thule nor at Fort Churchill. At the latter station the facilities of the Defense Research Northern Laboratory are devoted to defense projects involving application of the physical sciences. No systematic program of biological research has been attempted at Thule. Some types of biological research probably could be carried forward at these and other stations without interfering with defense efforts and without excessive expenditures of money or effort. Training of young scientists has been an outstanding contribution and must be continued and increased.

A. Recommendations for future research

The effectiveness of research in biology, ecology, and human factors in the Arctic can be improved, and research in these fields will contribute directly and indirectly to military operations in the Arctic. In order that these ends may be served, it is recommended that:

1. A complete list of all projects carried on at the Arctic Research Laboratory be compiled in order that costly duplication of effort be avoided, and so scientists

interested in doing research in the Arctic may ascertain the gaps in the general overall pattern of research. A similar list of projects completed or in progress at other laboratories would be very helpful.

2. A bibliography be prepared containing the titles of all published papers, books, and reports based directly on research conducted at the Arctic Research Laboratory.

3. A broad program of research in biology, ecology and human factors be adopted, that will center about man's adaptation to Arctic conditions, this program to give particular attention to: (*a*) adaptations of organisms other than man to Arctic environments, (*b*) the applicability of findings about "lower organisms" to the environmental problems of man, (*c*) the relationship of equipment used in the Arctic to the environmental factors, and (*d*) the relationship of these findings to the application of problems involved in emergency survival.

4. Cooperation among individuals and teams representing different disciplines be encouraged vigorously.

5. Whenever practicable, attention be given to one or more fields outside the special area of investigation thereby amassing information about phenomena and collections of specimens from poorly known regions.

6. Sustained effort be made to interest some of the personnel stationed at isolated posts to make scientific observations of a simple nature, and to collect specimens during their leisure hours. Engendering such interests among men so isolated would simultaneously add to the total knowledge about the Arctic and improve morale.

7. A natural history museum devoted to the life and paleontological history of the Arctic be established in order that new research workers may quickly gain a working knowledge of the Arctic biota.

8. Careful consideration be given to the formulation of tests, based on sound psychological practices, to determine the aptitude of prospective research workers for operations in the Arctic.

9. Much greater support be provided for the publication of findings and observations obtained during the prosecution of Arctic research projects.

10. At intervals of 2 or 3 years meetings be held at which selected representatives from various segments of biological, ecological, and psychological disciplines may discuss the problems, accomplishments, progress, and failures within the broad program of research outlined in recommendation (3) above, and make further recommendations for improving the research output.

B. Recommendations for improving United States-Canadian coordination in Arctic research

There has been reasonably good cooperation between United States and Canadian scientists involved with Arctic research in the past, but this cooperation can be improved and a higher degree of coordination of effort attained. To this end it is recommended that:

1. Arrangements be made to permit both civilian and military research personnel to visit laboratories and research stations, other than their own, in order that they may keep in touch with current research and application of new techniques, and enjoy the stimulation engendered by occasional conferences with fellow scientists.

2. The DEW line stations be made available to qualified research workers of both nations on an available-space basis.

3. Weather stations and other permanent and semipermanent installations in the Arctic be permitted to provide quarters, and other facilities when feasible, on an available-space basis, to research workers from both nations.

4. The Office of Naval Research encourage qualified Canadian investigators to carry out research projects at the Arctic Research Laboratory and at other Arctic stations under its cognizance.

C. Recommendations concerning utilization of Arctic facilities

Fuller utilization of existing facilities can be made without jeopardizing the primary objectives for which these facilities were established. The United States and Canada do not have as many Arctic research stations as required. In order to bring about fuller use of existing facilities and to provide for expansion essential to keeping ahead in the quest for knowledge about the Arctic, it is further recommended that:

1. Thinking be directed immediately toward increasing the number of Arctic research laboratories where investigations concerned with biology, ecology, and human factors—in addition to other kinds of research—can be carried on.

2. Steps be taken to make available the major DEW line stations as research and fieldwork centers when space is available, and that such research workers be permitted to make these stations their field headquarters, even though providing their own housing and mess, in order that they may maintain communication with their respective home bases.

3. That, when practicable, qualified scientists be permitted to accompany military detachments engaged in field maneuvers or exercises in poorly known areas in the Arctic.

4. That careful consideration be given to issuance of an order permitting appropriate scientific personnel to take passage on and make observations from resupply ships sailing into the Arctic when, and to the extent that, space is available on such ships.

5. That the possibility of using some of the space in the climate hangars at Eglin Air Force Base, when Arctic conditions are maintained in the hangar, be investigated. Many physiological, ecological, and psychological problems encountered in the Arctic could be attacked under the controlled environment hangar without detriment to the prime objectives involved in the Air Force experiments.

6. That thoughtful consideration be given to utilization of the Lockheed C–130 and the removable laboratory that this plane can carry, deposit on land or ice strips, pick up at a later date, and move to a new location.

VIII. COMMUNICATIONS, NAVIGATION AND DETECTION

The capability for unlimited operations in the Arctic regions by air and subsurface craft and limited operations for surface ships and vehicles has been proven. Inasmuch as we have this capability for operation in these areas, we must assume that our potential enemies are capable in the same areas. Research must be carried out sufficiently in advance to insure strength and advantage in ballistic missile control and warning, air warning, submarine warning, and that our forces are equipped with essential communications and navigations system and techniques in support of followup operations. Communication blackouts noted at Thule and Point Barrow could effectively neutralize our counter-offensive capability by the simple expedient of preventing communication of adequate information to operational units. Such blackouts might also be used to our advantage if we knew more about their cause and effect.

Of first significance to the problem of communications, navigation and detection in the Arctic is the subject of propagation of radio waves in, to and from that region. Research programs presently exist in the fields of ionospheric, tropospheric, meteor-burst, aurora-reflected, ground-reflected and earth-field alined ionized-patch reflected scatter propagation of radio waves. Further, there exist programs of study in the low and very low frequency region, as well as in the extremely high, millimeter-wave portion of the spectrum. These studies are not conducted particularly in Arctic regions, but characteristics and properties studied at low latitudes will be useful in studies of wave propagation in the polar regions. Environmental propagation investigations must be conducted to determine singular behavior of waves propagated in the several modes in Arctic regions. Particular emphasis must be placed on investigation of the physical mechanisms underlying blackouts, dropouts, and the influence of sunspot variations, solar prominences and showers on polar radio wave propagation. Experiments to ascertain advantages of using recently acquired information on new modes of propagation, such as those studied at Stanford University exploiting internal ionospheric tilt refraction, and the "whistler mode" very long range, very low frequency transmissions, must be conducted. Emphasis should also be placed on environmental investigations and tests of meteor-trail communications methods, and of long-range detection schemes using large antenna arrays to pick up signals scattered either through the troposphere or by some other mechanism. Studies in radio wave propagation unique to the polar regions must include investigations of conductivity and variations of ice water and land surfaces, as well as attenuation and propagation constants of mixed paths. The problem of use of the ice pack as a duct for transmission should be considered.

In the field of navigation, intensive studies leading to effective methods for navigation of submarines under the icepack are required. Inertial systems must be supplemented by long-range sonar and other acoustic systems. Investigations of possible application of various long-range electronic navigation sys-

tems, such as Radux, to this situation should be accelerated. Bathymetry of the Arctic Basin, bottom form, magnetic and gravity anomalies and sonar characteristics must be determined. In this respect, continuous wave fathometers placed on the sea ice stations instead of or in addition to sporadic seismic observations would be of great value. Aids to navigation on the Greenland icecap are urgently required. Also in the field of navigation, problems involving rendezvous using ultra-high frequency direction finding, and problems in very-low-altitude navigation to escape detection must be considered as related to the peculiar propagation conditions of the Arctic. Doppler and drift radar characteristics over the icepack must be investigated. Finally, the well-known difficulties of magnetic and gyrocompass navigation, as well as electromagnetic effects serve to affirm the necessity for much applied research leading to improved navigational devices and techniques for employment in the Arctic.

In the fields of detection, it is clear that existing early warning systems must be improved by vigorous, continuing programs of applied research in components and techniques for AICBM, aircraft and other vehicle detection. Unattended and other surveillance radar systems as well as data-processing equipment and techniques should take advantage of great strides being made in components improvements. Research in interferometric antennas, of the kind used in radio astronomy facilities, and in data processing of information picked up by arrays of antennas and fed into detection apparatus is going forward at many academic and industrial centers. Quantum-mechanical amplifiers of the MASER type, parametric amplifiers and low-noise crystal diode research is leading to extremely sensitive detection gear. These are applicable to the Arctic problem. Air Force tropospheric scatter "pole vault" circuits of the Labrador-Newfoundland area have indicated that the degree of reliability and channel capacity of the tropospheric link is such as to compel use of large antennas and high-gain power amplifiers to overcome degradation in propagation conditions. Increased detector sensitivity is a logical step in further improvement in this type of communication, and in detection. Circuit analysis and synthesis work, and digital data smoothing, integration and processing studies are quickly incorporated by engineers into improved system designs. Presentation schemes for easy, effective display of air defense and other situations required continued research in materials, and electrostatic and other methods of storage of electrical information.

IX. LOGISTICS

The logistics aspects of Arctic operations have commanding influence on the practicability and economies of those operations. For this reason, Arctic research and investigations in logistics can greatly assist in basic strategic decisions with regard to feasibility, desirability, and timing of new operations in the Arctic. In particular, it appears that this research can help directly in the enhancement of the nuclear-deterrent posture in the sense of increasing its effectiveness and reducing its cost.

Operations in the Arctic would be much more feasible with the extension of present knowledge and even present operations could be carried out more effectively and more economically than is now being done. To attain the desired increased capability requires a better understanding of the Arctic environment through basic research. In practice, of course, the use of environmental knowledge would be followed by applied research at specific sites, and by engineering research in equipment and methodology.

Arctic logistics includes applications and implications in regard to transportation, operations, maintenance, and construction. Of the above, transportation is by far the most important. As an example, it has been estimated that study of present practices and techniques of Arctic operations and the application of improved procedures might save up to 20 percent in DEW line resupply costs. In this connection there is specific need for more research in snow and ice because less is known about snow and ice than other segments of the Arctic environment. For example, a much-needed item to support operations at remote Arctic sites is a long-range air transport, ski-equipped, and possessing features especially adapting it for such operations. It would appear that we have the aircraft now, but require further basic studies in the properties of snow in order to permit design of a suitable ski. Large industrial operations have at least partially solved, through careful and unhurried study by capable specialists, many of the problems of the Arctic except those relating to snow,

ice, and oceanography, which private enterprise has had little occasion to pursue intensively.

There have been two limitations in the past hampering the efficiency of military operations. The first is the limitation of available information. Research and development work must be applied to the Arctic environment so that operations can be properly adapted from proven practices in more temperate regions so as to meet Arctic conditions. The second limitation is the unfortunate fact that in some instances available knowledge has not been used.

In addition to increased fundamental and applied research in the Arctic environment, two corollary segments of research are needed in the Far North. The first of these is the need to carry on basic research in order to train scientists in Arctic research, and the second is to develop new methods and techniques of research especially adapted to Arctic work.

The CHAIRMAN. Admiral Colbert, of the Coast and Geodetic Survey (retired), director now of the Arctic Institute of America, will now be heard.

STATEMENT OF ADM. LEO OTIS COLBERT, COAST AND GEODETIC SURVEY (RETIRED), DIRECTOR OF THE WASHINGTON OFFICE OF THE ARCTIC INSTITUTE OF NORTH AMERICA

Admiral COLBERT. That will be sufficient identification, I believe, Mr. Chairman.

As you know, I have appeared before this committee on several occasions while I was on active service for the Coast and Geodetic Survey, mainly for authorizing legislation for new and modern survey ships, particularly those we wanted to send into the Arctic and on improving functions of that Bureau.

The CHAIRMAN. It was quite a long time between drinks with the Coast and Geodetic Survey before they ever got a new ship; was it not?

Admiral COLBERT. That is correct.

The CHAIRMAN. How old were your ships when you had these new ones authorized?

Admiral COLBERT. The first time I think I appeared before this committee I was requesting authorization in 1938, and we constructed a ship that year and one the following year, and we haven't constructed any since that time. Ship life is usually 20 years. When you get into the hazardous waters and areas which you survey in Alaska, with unknown and unchallenged waters, you are subject to more hazards than you are in ordinary ship operations.

I think you will be interested to know that the Bureau has plans for laying the keel for the new ship, which this committee authorized, some time in March.

The CHAIRMAN. That ship is a replacement of an obsolete vessel.

Admiral COLBERT. That is correct.

The CHAIRMAN. You may proceed.

Admiral COLBERT. When I discussed before this committee the need for performing our operations in Alaska, ashore, in its great waterways, and over the vast offshore areas, I was able to draw upon my years of experience in hydrographic surveys of Alaska water and with knowledge gained through inspection of field parties engaged upon the geodetic work in the interior of the Territory.

Following my retirement from the Coast and Geodetic Survey I was asked to direct the activities of the Washington office of the Arctic Institute in North America. During my service in the Coast and

Geodetic Survey oceanography was one of our prime functions, that is, physical oceanography, as well as geodesy. I have been able to add to my engineering and scientific interest through the administration of the Washington office of the Arctic Institute of North America, because we had many scientific studies underway and of the technical reports from scientists making those investigations in various fields of work in the Arctic and the subarctic.

I would like to preface my remarks, Mr. Chairman, with a statement on the Arctic Institute of North America, which may afford a background for discussion of research needs in the north.

The Institute is the only scientific organization whose efforts are devoted entirely to the arctic area.

The Arctic Institute of North America is a nonprofit scientific organization founded in 1945 with the aid of the National Research Council of the United States and the National Research Council of Canada. Its purpose has been to advance and coordinate scientific studies of the North America Arctic and subarctic. Because the problems of the region are common to Alaska, northern Canada, and Greenland, an economy of effort can be obtained by treating this geographic area as a whole. The Institute was accordingly incorporated in the United States and in Canada. The Board of Governors are divided equally between those two countries and there is an additional Danish member representing Greenland. The research committee of the Institute and the directing officers who propose, review, and select, for their scientific merit, those projects which are to be supported by the Institute are experienced in Arctic research and in many branches of science. The officers are able to draw upon a membership which consists of scientists, individuals, and administrators, trained in northern work, for their advice and experience in proposed research investigations. The research program of the Institute determined by the research committee of the Institute, of which Dr. Reed is the chairman, is of the broadest possible character. Some of its projects deal with those aspects of science which can only be studied in the Arctic.

The Institute (1) conducts field research; (2) it provides basic tools, such as the Arctic Bibliography, for the use of all those concerned with northern development; (3) it disseminates information about northern studies through its journal, Arctic, and other publications; (4) it maintains liaison between the diverse groups and organizations concerned with northern research, and (5) it affords opportunities for practical experience to young scientists interested in Arctic studies, by working with senior scientists experienced in the Arctic environment.

Field research in the North America Arctic and subarctic forms our major effort. Nearly 300 field research projects have been undertaken. These have been in all the major disciplines of science.

Last fall at the request of the Chief of Naval Research, an ad hoc committee, jointly sponsored by the Arctic Institute of North America and the Office of Naval Research, convened for the purpose of examining the phases of Arctic research which might have military significance. Since Arctic research involves the total environment of the region and therefore a wide variety of scientific disciplines, this research is a direct concern to all military services. The committee made an on-the-ground evaluation of facilities for northern research.

It reviewed Arctic research programs by interviewing scientific and operational authorities of the Defense Research Board of Canada, Fort Churchill IGY rocket project; SAC, IGY, and Transportation Arctic Group operating in or out of Thule, including Ice Island T–3; Arctic Research Laboratory and IGY operating in or out of Point Barrow, Alaska, including Drifting Station A; University of Alaska, IGY and Aeromedical Laboratory operating in or out of Fairbanks; naval air station, Kodiak; and University of Washington, Seattle.

The report which Dr. Reed mentioned and which you have passed around, Mr. Chairman, is here and I have quoted certain parts. I think perhaps you might like to hear from some parts of this report, if we have time this morning for that.

The conclusions of the committee were supported by appendixes listing its findings and, in summation, stated briefly that considering the importance of the Arctic to the national defense, the committee recommended extended research in the fields of ice; oceanography and bathymetry; geophysics; landforms; meteorology; biology, ecology and human factors; communications, navigation, and detection; and logistics.

I would like to quote parts of the report of this ad hoc committee:

> The concept that the Arctic is a barrier to an aggressor is no longer tenable. Expanded Arctic research is essential so that we may extend our northern military frontier to the Soviet Arctic littoral. Our eastern and western military frontier abut the geographic borders of the Moscow-Peiping axis, whereas a vacuum exists in the Arctic Ocean area due to our lack of capability in this region.
>
> Geography canalizes the Soviet air-strike capability against the continental United States over the north polar desert, for reasons of distance and attack security. Russia's historic preeminence in cold-regions research, development and operations must be reckoned with in this connection. Large-scale, intensive and competent Arctic research development is being pursued by the Soviets without fanfare.
>
> This committee noted that we cannot rely on Arctic research by private enterprise since it has insufficient economic incentive to warrant rapid, large-scale expenditures of funds for scientific investigation of snow, ice, and related phenomena and for basic geophysical research on problems peculiar to the Arctic. Instead of past and presently planned financial starvation of fundamental and applied Arctic research, the volume of such research must be sharply increased. This increase should be immediate because of the years of lag between the obtaining of scientific data and their translation into operating capabilities.
>
> An absolute prerequisite to our effective use of the high Arctic is the harnessing of its environment. The Arctic's true military potential can only be transformed to the dynamic by means of studies specifically oriented to the problem. Modern technology will make possible military operations in the far north—under the ice, on the ice, and over the ice.

The Committee recommended that an intensive observation program be conducted in the Bering and Chukchee Seas. The program to include—

(*a*) Heat exchange between atmosphere, water, and sea ice;
(*b*) Heat transport by water currents;
(*c*) Movement of ice with wind and current;
(*d*) Ice coverage;
(*e*) Sea ice formation and disintegration; and
(*f*) The intrinsic physical-chemical properties of the sea ice.

The committee stated that observations are particularly required during the early fall and late spring by an icebreaker following the formation-advance of sea ice during fall and the disintegration-

retreat of sea ice in the spring. Operational significance lies in the predication of warm waterflow and of shipping conditions to Point Barrow and the northern Arctic coast. The proposed studies would include the confluence of the Beaufort Sea westward-flowing current and the Chukchee Sea northeastward coastal current. A similar study is required between Point Barrow and the Amundsen Gulf as a basis for predication of sea ice and the possibility of movement of ships along the north coast. The Amundsen Gulf is highly significant to submarine operations because of the reported permanence of open water throughout the year and the deepwater access of the area to the Beaufort Sea Basin. Studies of the Barrow sea valley and other offshore areas are also of importance to submarines.

A joint United States-Canadian program should be formulated to conduct a study of the influence of the MacKenzie River waters entering the eastern Beaufort Sea.

Dr. Reed spoke about the various Government organizations which have been conducting work in the Arctic and I will skip that.

As this committee knows, the atomic submarine *Nautilus* has made a recent cruise northeast of Greenland which included 1,383 miles of steaming under the ice in the central Arctic Basin and demonstrated the submarine capability at hand in the Arctic. If we are to exploit this Arctic capability and fulfill assigned military missions of the submarines, certain field research work must be accomplished:

(*a*) Bathymetric survey of the Arctic Ocean and the Canadian Archipelago.

(*b*) Oceanographic study to provide current drift, and water structure for application to navigation, sonar propagation, and sea-ice predication.

(*c*) Ice-coverage study, including distribution of thickness and size, and particularly size and distribution of water openings.

(*d*) Study of sea-ice-breaking strength from underneath and the physical-chemical properties of sea ice with regard to thermal conductivity and formation on surfaced structures.

Also for surface ship operations, complete hydrographic surveys, including tidal observations, must be made of those passages in the Canadian Archipelago not yet completed and should include studies of the surface and subsurface current movement, coverage and breakup of sea ice.

It is my opinion that these survey operations and comprehensive physical oceanographic and marine biological studies can be conducted by experienced hydrographic surveyors and scientists who could be assigned to the icebreaker for these specialized investigations. There is ample assurance that cooperation could be obtained from the Coast and Geodetic Survey, from the Navy Hydrographic Office, and from scientists supported by the Office of Naval Research, Arctic Institute of North America, and the Naval Science Foundation and others, in the broad regions of Arctic waters, in which our fundamental knowledge is most meager.

The CHAIRMAN. That concludes your general statement?

Admiral COLBERT. Yes, sir.

The CHAIRMAN. On page 11 of the Arctic Research Advisory Committee report you say, and I quote:

In addition to the shore observation posts, icebreaker support is required throughout the year to carry out observations at sea. Observations are par-

ticularly required during fall and spring by an icebreaker following the formation advance of sea ice during fall and the distintegration retreat during the spring.

I think you quoted this yourself, did you not?

Admiral COLBERT. Yes, sir.

The CHAIRMAN. You are a seafaring man. You have had a lot of experience with ships and vessels and you have other capabilities or else you would not be in this position you are in now.

With respect to the present availability, type, and character of our icebreakers, are they modern in every respect and sufficient to carry out the requirements that you point out in this statement?

Admiral COLBERT. No, sir.

The CHAIRMAN. The former witness mentioned the fact that Soviet ships stayed in their zone which I took it was comparative to the zone we are discussing, from one season to another season. We don't keep our ships in there similarly, do we?

Admiral COLBERT. No, sir.

The CHAIRMAN. Could it be then said that with the Coast Guard working in close conjunction with the Geodetic Survey there would be an advantage to science, to navigation, and to the study of the underwater passage of the north transit from the Atlantic to the Pacific particularly in the future by submarines and whatever underwater vessels may be developed?

Admiral COLBERT. Most decidedly, sir.

The CHAIRMAN. And that the Coast Guard have the most modern icebreaker with a type of power that would assure its continued operation longer than that now provided by the conventional icebreaker?

Admiral COLBERT. Yes, sir.

The CHAIRMAN. Then I take it that you would advocate the construction of a nuclear-powered icebreaker?

Admiral COLBERT. Yes, sir. I would like to advise you that my opinion is based upon my own information, my knowledge of the work we have been doing. It hasn't gone into the Arctic to the extent that we want to go or to the limits in certain things that we should know about the Arctic. The Russians are doing so much more than we are doing and they have been doing it for a long time.

In the Arctic bibliography we have been compiling Russian literature, Russian technical reports, although a great deal of the reports we get from Russia comes from magazines. Our staff is made up of trained people interested in science as well as being linguists and they are reading 200 Soviet magazines we are able to lay our hands on.

To go back to talk about the northern sea route, Mr. Chairman, in 1932 the Chief Administration of the Northern Sea Route was founded by the Soviet Government to develop an Arctic shipping lane for passage from the Atlantic to the Pacific. This was in 1932. The Soviets realized the need for knowledge of the ice, and weather conditions, and of the hydrography of the Arctic Ocean. They began a program of research which included observations from a net of polar stations, from ships, and drifting ice stations, and from aerial reconnaissance.

The program extended deeply in the Arctic Basin, some stations near the pole.

We knew that they were doing this in 1932. Then following the early years of World War II up to the middle of 1954 almost nothing

was reported or known about the Soviet activities in the Arctic. This total silence came to an abrupt end in July 1954 with the announcement that a new Soviet Arctic expedition had been set up in the Arctic Basin.

It was revealed as the biggest research undertaking ever launched in the Arctic. It consisted of 3 types of research units, 2 drifting stations, such as Dr. Reed spoke about a little earlier. These have been called North Pole 3 and North Pole 4, which indicated they had North Pole 1 and 2 prior to that.

They were permanent bases for long-term research, and they had several mobile airborne research groups which could make landings of short durations at the various spots determined in advance. They also had several flying observatories which made systematic nonstop flights over the Arctic and had instruments for recording meteorological and hydrological observations.

All of these units on the ice were well equipped and supplied. A fleet of large aircraft carried the personnel and equipment and supplied the drifting stations the year around with provisions, fuel, and mail.

The camps of the drifting stations were equipped with prefabricated huts and new types of tents heated by gas and lighted with electricity. They were supplied with jeeps, tractors, small airplanes, and helicopters. The staff of each station consisted of permanent personnel.

On North Pole 3 there was a crew of 17 permanent men and they had guests, mostly scientists who came from time to time to carry out their particular investigations.

The CHAIRMAN. In conjunction with that, have you any idea that there is any connection between the facts that you have just read into the record and the construction by the Soviet of a nuclear icebreaker?

Admiral COLBERT. Yes; there is no doubt about it. The Russians used icebreakers to inaugurate that northern sea route. They have made trips forward and back in a single season. Most of the transfer of ships and small boats has been made during the open season, but they have had an ocean ship go all the way to the Bering Sea and back within one season.

You will recall there are three large rivers that flow into the Arctic from Siberia, the Ob, the Yenisei, and the Lena. At the headwaters of those rivers, the Soviets are setting up great industries and factories. These ships went on their own power from Archangel along the sea route and entered the mouths of the river to proceed to these areas.

We can say that the Russians have an advantage over us on this continent, because of those rivers. Not only at those three large river mouths but at several others, the ice breaks up and fresh water flows to the Arctic. It breaks up the ice at the mouths of the rivers and the water will flow along the coastal area so that you have a channel following the coast which is ice free much earlier than the channel that we have from Point Barrow to the MacKenzie River.

On our Arctic coast, in the early days, whaling was a great industry. Whalers followed the whales up north and were icebound inside. They went all the way to Herschel Island, which is very close to the mouth of the MacKenzie River.

As a boy I had read of whalers in this particular area. Flying over that area some years ago I found out why. We followed the shoreline, flying about 200 feet above the terrain and the icepack was close against the Arctic coast. It wasn't possible for a ship to make passage at that time on the 24th of June.

As we reached Herschel Island we saw blue water. Admittedly at 200 feet we were limited to about 10 miles of observation maximum. The reason for the ice-free blue water was the fresh water flowing out of the delta of the MacKenzie River and melting the coastal ice. There are two reasons why the whalers went behind Herschel Island. They were free from the crushing effect of the ice in the open sea because they were on the lee side of the island.

On the other hand, they had a month or more whaling in the open water, before the lead opened for the return trip out around Barrow and down the coast into the Bering Sea.

I have here several excerpts from our compilations for the coming volume of the Arctic bibliography. Our staff, which is located at the Library of Congress, in compiling this work, furnished me with a complete text of a Russian report in Pravda published in February 1956. I think you would be interested if I should read some of it. This is in regard to the proposed atomic-powered icebreaker, which they were to build.

The CHAIRMAN. Yes, sir; I would like to have that in the record, sir.

Admiral COLBERT. It says:

> Soviet scientists and ship designers have already worked out the details of such a vessel which will be used in the Arctic. It will be a vessel of a new type and will permit a change in the tactics of navigation through ice, making it possible to prolong voyages in the northern seas, to master higher latitude shipping routes, and to broaden the research front in the central polar basin.
>
> This will be the true vision of S. O. Makaron, the noted Russian navigator, who dreamed of reaching the North Pole in an icebreaker.
>
> The use of atomic energy will mean that the icebreaker will have several important advantages over coal or oil-powered and also diesel icebreakers.
>
> Atomic-powered icebreaker will be 50 percent more powerful than the conventionally powered icebreaker of the same dimensions and will be able to travel 10 to 12 times as far without refueling.
>
> Up to 30 percent of the displacement of an ordinary icebreaker is consumed by the fuel, of which it must carry thousands of tons.
>
> An icebreaker of the Soviet fleet, for example, carried 3,000 tons of fuel and its daily expenditure exceeded 100 tons. This prevents icebreakers from staying far from port for extended periods.
>
> The fuel (uranium) expenditure of an atomic icebreaker is measured in grams and thus its range of navigation is practically unlimited.
>
> The designers can use part of the vessel's displacement that would ordinarily be used for fuel storage to increase the power of the engine and to strengthen the hull. Such an icebreaker will be able to break through the rough Arctic ice that is impregnable to present-day icebreakers.
>
> The main engines of the new icebreaker will have a 44,000-horsepower capacity. Its cargo capacity will be limited to 16,000 tons, and it will be able to carry sufficient supplies to remain away from port for a full year.
>
> Every provision will be made for the useful work, cultural leisure, and rest. Sailors will be quartered in single- and double-berth cabins, which will be airconditioned and provided with fluorescent lights. Living quarters will be comfortably furnished. There will be wardrooms, lounges, a club, a motion-picture theater, a library, and sickbays.

And so forth.

The CHAIRMAN. Admiral, in your position as Director of the Coast and Geodetic Survey you are aware of the responsibility and the prerogative delegated to the Coast Guard; aren't you?

Admiral COLBERT. In some manner; yes, sir.

The CHAIRMAN. And the Coast and Geodetic and the Coast Guard generally work pretty closely together?

Admiral COLBERT. Yes, indeed.

The CHAIRMAN. So you would say that a ship of this type could be properly placed in the Coast Guard?

Admiral COLBERT. I should say that it would be properly placed in the Coast Guard.

The CHAIRMAN. Then it seems from the article you have read, which I presume is correct, that the Soviet Government is more advanced in their thinking than we are.

Admiral COLBERT. Mr. Chairman, they have been thinking about this Arctic area for years. There is no nation in the world that is up to them.

The CHAIRMAN. And they are more progressive and desire to get more information?

Admiral COLBERT. That is right.

The CHAIRMAN. And we haven't kept abreast of the times, then; have we?

Admiral COLBERT. No, not quite.

The CHAIRMAN. I would like the other members of the committee to have an opportunity to ask you questions, but the House is in session and there is now a call of the House, and I will have to adjourn the committee until tomorrow morning.

Would you like to ask some questions?

Mr. ALLEN. Yes, I would.

The CHAIRMAN. Admiral, will you return tomorrow morning at 10 o'clock?

The committee will now stand adjourned until 10 o'clock tomorrow morning.

(Whereupon, at 12:15 p. m., the committee was recessed, to reconvene at 10 a. m., Thursday, January 23, 1958.)

20716—58——5

ATOMIC ICEBREAKER

THURSDAY, JANUARY 23, 1958

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D. C.

The committee met, pursuant to recess, at 10:05 a. m., in room 219, Old House Office Building, Hon. Herbert C. Bonner (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

We will continue with Admiral Colbert the witness this morning.

STATEMENT OF ADM. LEO OTIS COLBERT, COAST AND GEODETIC SURVEY (RETIRED); DIRECTOR OF THE WASHINGTON OFFICE OF THE ARCTIC INSTITUTE OF NORTH AMERICA—Resumed

The CHAIRMAN. Mr. Allen.

Mr. ALLEN. Admiral, we have been talking a lot about this icebreaker and have emphasized the benefits it would be to Alaskan research.

Now, I am getting a little disoriented. If you can do so, I would like you to state briefly what other installations or equipment might be required for the type of research program that you envisage and put the icebreaker a little bit in perspective for me.

Admiral COLBERT. You mean throughout the Arctic area?

Mr. ALLEN. Yes.

Admiral COLBERT. Can you gentlemen see this chart? This is the top-of-the-world chart with the Russian area over here. The red spots are the locations of IGY stations—that is, stations which will do all sorts of geophysical work, make all sort of geophysical observations throughout the IGY.

This has been going on for several months. The IGY ends in December this year.

This group over in here are the IGY stations under our national committee of the United States. In addition, there are weather stations scattered through this area through here which are joint Canadian and American meterological stations.

Now, we need to make a survey along the coast here, in order that we can approach any part of the Arctic coast of Alaska as well as get into the Canadian archipelago, this group of islands here.

I think Admiral Will pointed out yesterday that he made the cruise through the passage here. That passage had been used by smaller ships previously, but they determined that it was feasible for larger ships to go through. However, there are no surveys. There are no tidal stations.

The Coast Survey publishes the tides for ports all over the world, but the stations for this area are from a few observations, and are not sufficient for the type of knowledge we need, especially if we are going to study the differences in sea level.

Now, the Coast Survey has surveyed the shoreline to Demarcation Point, where the Alaska boundary comes to the Arctic coast. Inshore hydrography there has been done, but it is limited to what they could do from the shore in small launches.

The whole area from Bering Strait into Bering Sea and Chukchee Sea should be surveyed, and that can best be done by a hydrographic survey complement on an icebreaker.

Nineteen hundred and fifty-one to nineteen hundred fifty-four two icebreakers were up in this area and used EPI equipment. That is a type of development by the Coast and Geodetic Survey to establish shore stations and reach out by radio to give a precise location for the ship at any time. Those precise locations will then identify the exact location of the sounding, the depth. And that is very important in this area.

We know that there is a submarine ridge. The Lomonosov Range was discovered by the Russians in their drift station across here. In the IGY and in the work of this station (Alpha), here, they drifted over a second ridge. Continuous soundings were obtained by United States observers up to the top of the ridge and back on the other side. So we know there is a ridge, and we estimate it is in this general direction.

There may be other identifiable landmarks on the Arctic Ocean bottom. The configuration of the bottom is not that of a flat plane, and there will be peaks, ridges, and everything else. When you have no celestial objects, a submarine or icebreaker can determine its position by bottom location just as well as we do now along our coasts here on the Atlantic coast, where there are completed surveys with sounding accurately located.

Now, during the period this is going on there should be companion observations made on shore along our Arctic coast and over in the Canadian area. Our cooperation with the Canadians is good in northern scientific investigation.

On board this icebreaker there should be sufficient scientists to cover the geophysical branches of scientific knowledge. We need meterorolgical and climatological observations. We need magnetics. We need the soundings, constant soundings. We need the biologists on board to determine the character of the water, the productivity of the water, the chemical composition, etc.

We find polar bears out through this area. The polar bears live upon the seals. Seals live upon fish. What do the fish live upon? That's the plankton. We have to find out the type of plankton and what it is and where it is more productive in some areas than others.

One of our investigators of the Arctic Institute of North America examined the ice-free waters or the melt waters from the ice. He found them very productive. And the result was the fish were following up the edge of the melting ice.

All this adds to our scientific knowledge and comes to use in our defense or in our attack, because the military can use that information.

Now, that means that you will have to have a number of different

scientists, because of various disciplines, aboard this ship making the observations. They should make around-the-clock observations, which will increase the number of observers that will be necessary.

Mr. ALLEN. Well, percentagewise, or moneywise, if you can do it, how much of that work is to be done from an icebreaker and how much is to be done from the other installations or with other equipment?

Admiral COLBERT. Well, practically all of it or the major part of it should be by icebreaker. Smaller ships can follow in the leads or near them where the water is free of ice.

But remember that that area is not ice free and you cannot get around Point Barrow here in some seasons till after the 1st of July. Then you have to get out in September.

In other seasons the area may open up. I think in 1951 we had quite a free area this way. Last year it was closed in, and the eastern Arctic opened up. That happens frequently. I think next year we will have a more open season on the western Arctic than this year and the eastern Arctic will be closed in for a longer period.

Mr. ALLEN. Is there any way you could appraise the dollar value of the result of your effort after 5 or 10 years?

Admiral COLBERT. I used to make an estimate some years ago to figure the amount of loss of ships, not regarding lives, and the insurance rates throughout Alaskan waters. When our surveys and wire-dragging were accomplished through the inland passages our insurance rates on the ships to Alaska dropped measurably.

Now, it's a matter of insurance here, and not only on our ships. I am thinking about our defense ships as well as the lives on board. I do not think you can really measure that in monetary value. But it is a great insurance to have them free of that danger; also they need it in order to function.

The submarine, to operate in the area, can do so under the ice with the knowledge of the bottom, knowledge of the currents. Of course, they will have other equipment for coming up through the ice. It will be very important to study ice conditions, thickness, location of leads, etc.

Mr. ALLEN. I presume we will ultimately resolve on some figure that will be the present cost of an icebreaker and then ultimately will have to justify the cost of the icebreaker against some other offsetting benefit in dollars. I was trying to get a justification.

Admiral COLBERT. Yes; I see.

Well, I think it is a matter of defense also as some of the previous speakers have mentioned. Note the route across the Arctic. Here is Russia, and New York, and Washington, and Seattle. The route across is here.

The Arctic region channelizes the area of attack by the Russians from any part of this great area here from Siberia to Archangel. They come over uninhabited lands because few North Americans live up in this area. The Russians do live in this area, colonized by their methods of communistic work.

Mr. ALLEN. Thank you, Mr. Chairman.

The CHAIRMAN. Admiral, along the line Mr. Allen was talking, did you include in your general statement or was it in that pamphlet that we included in the record a description of the accommodations aboard the Soviet icebreaker that is now just being launched and is practically ready to operate? I read it last night.

Admiral COLBERT. Yes.

The CHAIRMAN. It goes on to show the quarters that are provided for such people as you mentioned in your statement just a minute ago.

Admiral COLBERT. Yes. I think I mentioned from the translation.

The CHAIRMAN. We might say that this icebreaker the Soviet Government is building is for icebreaking purposes as well as scientific study in the north?

Admiral COLBERT. Yes, for scientific study, research, as well as opening up the channels through the ice.

The CHAIRMAN. Yes.

Admiral COLBERT. Let me see if I have a note here. Well, they have been working in this area, to get away from the Arctic a little bit to the area just below here. The Russians are working just as we have been working up on our coasts. I think they had seven research vessels in there in the past few years. And it is most interesting to note that one of them would be comparable to our largest survey ship. And, of course, the Russians do things a little larger, a little more, I think.

This ship, the *Vityaz*, is 5,000 tons, and she has elaborate ship accommodations, and carries 80 scientists on board. That would include a surveying crew to survey these uncharted waters.

She has a large, deep-sea bottom coring and trawling winch. She is able with the winch to drop the core sampler to the bottom, explode it, and get 10 feet penetration. Then take the core out and examine it later at the laboratory.

This winch is unusually large in order to accommodate the very deep depths that they have there to reach the bottom.

Also the winch has to take care of the trawling when they wish to collect various types of sea life, plankton, and so forth.

It has separate winding and storage spools depending upon how much depth they are going to use.

It is very interesting to note that it is a stepped-up wire. At the lower end it will be very fine wire, and then gradually it will taper and increase in diameter, because all the friction and pullback of the trawl or of the core or of the bottom-sounding apparatus will make it necessary to have the tensile strength sufficient at the winch.

I would like to note that 80 scientists are aboard this ship.

Now, I think that on the *Lenin*, which is a new ship, capacity 44,000 horsepower, cargo 16,000 tons, will have 200 scientists on board as a minimum, because there is plenty of work they can do on a larger ship.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. No questions.

The CHAIRMAN. Mr. Ray?

Mr. RAY. No questions.

Mr. SHEEHAN. No questions.

The CHAIRMAN. Mr. Lennon?

Mr. LENNON. No questions.

The CHAIRMAN. Mr. Pelly?

Mr. PELLY. Just one question. Is there any evidence of a fishery in the Arctic?

Admiral COLBERT. Yes. The Russians are doing a great deal. One of the reasons for an icebreaker—you can think up more things as long as you continue discussion a little bit—one of the major efforts was to examine fisheries. With the melting of the ice and the warming of the

water, they found that more and more fish are going into the Arctic. And they have been interested and they have worked the icebreakers. They have built up a fishery fleet.

Mr. PELLY. How about in the waters north of Alaska and Canada? Do we know of a resource there that exists?

Admiral COLBERT. Well, we know in recent years the codfish have worked up along the west coast of Greenland. They are north in the Atlantic further than they ever have been before. They worked up into the straits, and we know that they are coming up on the other side. They have been found by the biologists in scattered places along that area.

We are studying the glaciers. We have scientists working on the glaciers of Greenland and in Alaska on the Northern Brooks Range. It looks as though the temperature or the climate is warming up.

One scientist is studying gas enclosure in the ice, from an iceberg coming off a glacier here in southern Greenland. It must be very old ice, maybe 10,000 to 30,000 years old. And by his analysis and precise measurements he can determine the amount of CO_2 or oxygen which was confined in the snow which landed on that glacier that long ago, to give us some idea of the climate and atmospheric conditions of that time.

Now, we do know from history that there were fish up in this area years ago, because they came over from Europe to find them. It seems as though they are coming back. That seems to be the trend. There is no question but that the fish are proceeding north.

Mr. PELLY. Well, in the exploratory work that has been done in the Northwest Passage and when those icebreakers have come through there, have they been able to catch halibut or shellfish or any——

Admiral COLBERT. Yes, they have. There are Eskimos. They catch shellfish and smaller fish. The tomcod are there, and the Arctic char.

Mr. PELLY. Is there any possibility there could be a valuable resource up there we do not know about?

Admiral COLBERT. There is a possibility.

And one of the things we are interested in is the plankton study to find out what fish could live on and to find out whether plankton are sufficient for their survival.

The CHAIRMAN. Any further questions?

The counsel would like to ask a question.

Mr. DREWRY. Admiral Colbert, did you read the entire text of that article you were reading yesterday?

Admiral COLBERT. I left it with you.

Mr. DREWRY. I wonder if we could have it for the record, Mr. Chairman.

The CHAIRMAN. Yes.

(The article above referred to follows:)

The Soviet Union's successes in developing nuclear physics, radiochemistry, automation, telemechanics, electronics, and other branches of science and technology make possible widespread work on the peaceful use of atomic energy. A great deal of experience in the use of atomic power installations has already been amassed in our country; the world's first atomic plant for producing electric power has been built and has been operating successfully for more than a year and a half.

This presents an opportunity for the wider use of atomic energy for peaceful purposes in the sixth 5-year plan. The draft directives of the 20th Party Congress

worked out by the Central Committee call for the building of atomic powerplants with a capacity of 2 million to 2,500,000 kilowatts in 1956–60 and for broadening work on the creation of atomic engines for transport purposes.

An atom-powered icebreaker is to be built. Soviet scientists and ship designers have already worked out the technical details for such a vessel, which will be used in the Arctic. It will be a vessel of a new type and will permit a change in the tactics of navigation through ice, making it possible to prolong voyages in the northern seas, to master high-latitude shipping routes and to broaden the research front in the central polar basin. This will bring true the vision of S. O. Makarov, the noted Russian navigator who dreamed of reaching the North Pole in an icebreaker.

The use of atomic energy will mean that the icebreaker will have several important advantages over coal- or oil-powered, and also over diesel, icebreakers. The atom-powered icebreaker will be 50 percent more powerful than a conventionally powered icebreaker of the same dimensions and will be able to travel 10 to 12 times as far without refueling.

Up to 30 percent of the displacement of an ordinary icebreaker is accounted for by fuel, of which it must carry thousands of tons. An icebreaker of the Soviet Arctic Fleet, for example, carried 3,000 tons of fuel, and its daily expenditure exceeds 100 tons. This prevents icebreakers from staying far from port for extended periods.

The "fuel" (uranium) expenditure of an atomic icebreaker is measured in grams, and thus its range of navigation is practically unlimited.

The designers can use the part of the vessel's displacement that would ordinarily be used for fuel storage to increase the power of the engine and to strengthen the hull. Such an icebreaker will be able to break through rough Arctic ice that is impenetrable to present-day icebreakers. The main engines of the new icebreaker will have a 44,000-horsepower capacity. Its cargo capacity will be 16,000 tons, and it will be able to carry sufficient supplies to remain away from port for a year. Every provision will be made for the crew's fruitful work, cultural leisure, and rest. Sailors will be quartered in single- or double-berth cabins, which will be air-conditioned and provided with fluorescent lights. Living quarters will be comfortably furnished. There will be wardrooms, lounges, a club, a motion-picture theater, a library, and sickbays with modern medical equipment.

The ship's personnel will be well protected against the atomic engine's harmful radioactive radiations. The engine will be controlled automatically from a distance. The crew's work will be considerably lightened by automation and telemechanics. Operators at a control panel will replace stokers.

The icebreaker will be able to operate under the Arctic's severe and extremely complicated weather conditions. It will have to find its way through fog and falling snow and the gloom of polar night. Modern navigational and radar installments will insure safe navigation and reliable liaison with ships that it convoys through the ice. The ship will be provided with two helicopters for reconnaissance over the ice. Control of the ship will be automatic to the fullest possible degree, and will be exercised by the captain from the upper bridge or from the wheelhouse.

Preparations are now underway in one of our country's shipyards for the construction of this new vessel—the first atom-powered icebreaker.

Mr. DREWRY. I believe that article shows that the personnel accommodations on the *Lenin* are 1,000; that the personnel accommodations on the new Russian icebreaker are 1,000.

Admiral COLBERT. No; it does not state it, and I tried to obtain that.

Mr. DREWRY. I have an itemization of the ship's characteristics which the Navy sent me, in which they list it as 1,000.

Admiral COLBERT. That is what it says—1,000?

Mr. DREWRY. Yes, sir. And it would be more understanding or your information that that very large number would be because of the additional opportunities for research and so forth?

Admiral COLBERT. That is right. If I am not mistaken, this ship is 91 feet beam You can imagine the size of the accommodations you can put on board. And the Russians are going to put just as many people as they can on there to do all the various types of work.

If there is any open water, they are going to launch small boats and go out and make observations, with the icebreaker as base.

They are going to have helicopters on board. They will make landings on the ice as they did on some of their other work. They flew expeditions and landed them on the ice pack. They will do the same thing with this ship. There may be 20 or 30 parties scattered in all directions on the ice. They will make their observations and then return to the mother ship.

Mr. DREWRY. Do you know how that compares with the accommodations on our largest American icebreakers?

Admiral COLBERT. I know that the *Glacier* had a crew of 229. I think that the *Wind* class of the Coast Guard have between 195 and 200. Admiral Richmond, is that right?

Captain CURRY. Two hundred.

Admiral COLBERT. That is the figure I estimated.

Mr. DREWRY. I just wanted to get that comparison in the record. That is all, Mr. Chairman.

Admiral COLBERT. That ship, of course, is 5,300 tons for comparison of accommodations.

The CHAIRMAN. Thank you very much.

Admiral COLBERT. I would like to present the committee with this National Geographic map, entitled "Top of the World."

The CHAIRMAN. Thank you. We will accept it with a lot of pleasure. We will hang it on the wall of the committee room.

The next witness is Dr. Paul A. Siple.

Do you have a general statement, Dr. Siple?

STATEMENT OF DR. PAUL A. SIPLE, GEOGRAPHER AND POLAR EXPERT

Dr. SIPLE. Mr. Chairman, I have been asked by your counsel to talk for a few minutes this morning about the Antarctic regions.

Over the past 30 years I have made 6 separate trips to the Antarctic and in that period have wintered over 4 times. In my work with research and development I have also spent some time in the Arctic.

Approximately a month ago, I returned from the South Pole where I spent a year as scientific leader for the National Academy of Sciences in carrying out that portion of its International Geophysical Year program. My services were on loan from my regular employment with the Department of the Army where my work has been concerned with research and development including polar research.

My observations this morning are personal and do not represent the views of any government or nongovernment agency. Specifically, I am not speaking for the Department of the Army or the United States National Committee of the International Geophysical Year.

Your counsel has asked me to speak this morning on three specific points. The historical background and the current status of Antarctica, the operational difficulties involved in Antarctica exploration, and the future prospects of Antarctica.

Historically, we can go back as far as the period of the American Revolution, when Captain Cook, the British explorer, in the course of his world travels, sailed the first ship around the Antarctic continent without sighting land. Because of the forbidding nature of the seas,

he predicted that no one would ever attempt to travel farther south. It is obvious that he did not anticipate modern icebreakers.

Thirty-seven years later two Russian warships, under command of Bellingshausen, circumnavigated the Antarctic and near one of the few spots where land was sighted, the expedition met Captain Natanial, an American sealer, busy hunting seals. During the early part of the 19th century, many American sealers and whalers operated in and through Antarctic waters.

The first American Government-sponsored expedition that ventured into the Antarctic in 1840 was led by Lieutenant, later Admiral, Wilkes. This magnificent voyage into the southern latitudes was made in ill-equipped sailing ships. Some record southings made by Wilkes were not broken until recently.

Until the very end of the 19th century, no one had established a base or wintered over on the continent, though several expeditions had been caught in the ice and held prisoner. One was the Belgian scientific expedition which drifted with the pack ice for a year in the Bellingshausen Sea, just to the west of Palmer Peninsula. The danger of being held imprisoned in the ice for such long periods and the hazard to life deterred most vessels from venturing into the area.

It was nearly a hundred years after Wilkes before the United States sponsored a formal expedition to the Antarctic. The first Byrd expedition in 1928 made the venture prepared to prove the feasibility of using aircraft to explore to the very center of Antarctica. Byrd purchasd an old wooden sealer, the only icebreaker available at that time for the voyage. This 80-year-old sailing vessel had an auxiliary engine with a powerplant approximating that of a modern passenger automobile. If it had not been for the aid of a Norwegian whaling ship, which towed our ship through the icepack, the first Byrd expedition might never have succeeded.

At that time, I believe, the world's only metal icebreaker was the Russian vessel, *Krassen*. However, the factory-type whaling ships of the period were sufficiently reinforced to operate in icefields but not to act as real crushers comparable to present icebreakers.

The primary objective of the first early Byrd expeditions was to get through the icepack and somehow put material for bases and aircraft ashore.

One hundred years after the Wilkes expedition, the United States Government again took an active interest in the Antarctic and authorized the use of Government ships for operations in the area. At that time the only ships available to serve as icebreakers were the former Coast Guard cutter *Bear* and the Interior Department's *North Star*. The wooden ship, *North Star*, with its power and ample holds, was, to an expedition man, one of the finest designed polar ships of the period. Speaking as an explorer, I find that a primary objection to modern icebreakers is their lack of usable cargo space.

We did succeed in 1940 in establishing two bases, one at Little America, and one at Stonington Island, Marguerite Bay in the Palmer Peninusla area, and had intended to establish a base at Herd Island which was first discovered by an American but has since been taken over by the Australians.

If President, Roosevelt's desire in 1940 to make the United States Antarctic Service a permanent organization had been fulfilled, we

would have been in the Antarctic continuously since that date. The war forced us to abandon our bases.

The Palmer Peninsula, that portion of the Antarctic Continent reaching up toward South America, has certain strategic value to the United States. The loss of the Panama Canal would make the Drake Straits area between the peninsula and South America a vital sea-lane between the Atlantic and Pacific Oceans. During both World Wars, the islands near that tip of Antarctic have been occupied or used for hiding spots by enemy ships and submarines. On behalf of the allies, the British, during World War II, occupied several of these islands in order to keep the area under surveillance. Since then, surveys were initiated and the British are still occupying the sites. Currently, they are using civilian contractors to make aerial surveys of the region.

I am sure you will all recall Operation Highjump right after the war, when three units of United States naval vessels, well equipped with aircraft, made up the largest expedition, up until then, to visit the Antarctic. The central group of this operation was led through the Ross Sea icepack by the *Northwind*, first modern American ice-breaker available for use in the Antarctic. Most of the outline of the continent was completed for the first time as a result of this memorable expedition.

Several years back, when the plans for an International Geophysical Year came into being, 12 of the 50 countries participating in special earth science studies of the entire world set up a special program for the Antarctic. In order to make progress in the geophysical sciences that are affected by varying conditions in different locales, particularly in the areas of weather, magnetism, ionospheric physics, cosmic radiation, aurora, and related sciences caused by sunspot effects, it is necessary to have stations around the world studying and recording data in these fields simultaneously. One most important blank area in the chains of worldwide IGY stations was in the far south.

As demands and interest grew, United States participation in the Antarctic portion of the IGY program expanded. Establishing the American station at the South Pole was one of the many technically trying problems we faced in establishing our seven Antarctic IGY stations. We are now beginning to get very valuable scientific results from our first IGY in the Antarctic as we replace "guesstimates" with factual information concerning the whole continent.

You will see, as I point them out on the map, that the 12 participating nations man stations are pretty well distributed around the whole Antarctic continent, except perhaps in the Marie Byrd Land sector along the Southern Pacific Ocean.

Much of the United States activity took place here in the Ross Sea area to the south of New Zealand. The two largest United States bases at McMurdo and Little America are here. From them comes support for our principal inland stations at the Pole and in Byrd Land. Also in the Ross Sea area is the New Zealand's Scott Station, close to McMurdo, and Hallett Station, jointly operated by the United States and New Zealand.

In the Palmer Peninsula region, below South America, there are some 20 or 30 small permanent stations belonging to Britain, Argentina and Chile, which are taking some part in IGY. However, to the east a bit in the Weddell Sea area, south of the Atlantic Ocean, are several

of the larger IGY stations. First, going clockwise, is our own Ellsworth station (until recently under command of Captain Ronne). Next is Belgrano, the Argentine station, and then Dr. Fuch's British station, named after Shackleton. All 3 of these stations are close neighbors, less than 50 miles apart. A little farther up the coast to the east is Halley Bay, the British main IGY station.

At wider intervals, continuing around the continent, are IGY stations of Norway, Belgium, Japan, and two of Australia. In this sector, south of Australia, are also two coastal Russian stations supporting 2 or 3 inland stations. Nearby the United States Wilkes Station under Carl Eklund, which has a small inland station. Between Wilkes Station and the Ross Sea, the French have a coastal station and an inland station in the vicinity of the south magnetic pole.

In addition to these continental stations, there are other IGY stations on sub-Antarctic islands manned especially by New Zealand, Australia and South Africa.

Now, to mention some of the difficulties involved in ships operating in Antarctic waters, especially along the coast of Marie Byrd Land. This coastal area has, to date, not been reached directly by ship. Up to now, all exploration of this region has been made by aircraft based on ships far at sea or by approaching the area from the side by dog teams, tractors and aircraft.

To date, we have been deterred from the most desirable method of operating in the area by lack of icebreakers. Heavy icepack stretches out for two or three hundred miles, so far barring normal operations along the coastline from the air and I personally believe that if a ship could get through the icepack, it should be possible to skirt a good portion of this coastline and conduct much needed scientific surveys of the region.

Up to now, we have had to operate mostly from harbors in territorial segments claimed by other countries. Many of the countries claiming segments of the Antarctic are prone to indicate the Marie Byrd Land and Ellsworth Land as a United States claim. Actually the United States has never made an Antarctic claim but it is significant that after all we have done to explore Antarctica, we have been left only the portion that has no ports.

In the Ross Sea area, claimed by New Zealand, ships can usually find openings in the icepack throughout the summer months, and with moderate sized icebreakers of the *Wind* class, move through the ice without too much trouble. Occasionally, even here, ships run into difficulty such as we encountered during Operation High Jump, when it took 3 weeks for the *Northwind* to lead a group of naval ships through the pack. In this case, an icebreaker of the *Wind* class did not prove adequate since its maneuverability was not matched by a beam wide enough to leave a clear straight passage for cargo-type vessels. As a result, a number of the thinner skinned vessels being escorted were damaged.

The vexing problem in Antarctic operations is fuel—fuel for ships, aircraft, vehicle operations, and heating—its bulk, weight, and cost. It has been estimated that fuel delivered to the South Pole costs around $10 a gallon. Those of us warmed by it did feel privileged but we couldn't help but shudder when a bit spilled.

Icebreakers with essentially unlimited fuel supplies could give an expedition far more freedom of operation. Such crushers could be

operational in the icefields for prolonged periods, dispelling any fear of danger or severe hardship if locked in the icepack. At present, most icebreakers are limited to 2 or 3 months' operation in heavy ice before being forced to return for resupply of fuel.

It is obvious that in respect to fuel requirements, an atomic-powered icebreaker would be useful. In addition to being able to operate for indefinite periods in icepack areas, an atomic-powered icebreaker could, in place of fuel loads, carry cargo and, thus, without the aid of other vessels, supply land bases otherwise difficult to reach. Such a ship, if fitted out as a laboratory, could serve as a base of operations a representative of the Department of Defense, Army, or the National

Turning now to the topic: the future prospects of Antarctica, as I see them; I wish to repeat at this point that I am not speaking as a representative of the Department of Defense, Army, or the National Academy of Sciences.

First, it is my personal opinion, as we look to the future, that there is every indication that the occupation of Antarctica, on a permanent basis, will continue. My statement about "permanent basis" is a qualified one in that for some time to come, personnel will continue to turn over annually at the various stations.

The biggest commercial venture in the Antarctic is one in which we no longer take any direct part. This is the whaling industry, which is controlled by international agreements. Although we buy a large portion of the whale oil, we operate none of the large international fleet of whalers hunting in that area.

Based on limited prospecting for minerals, to date, accomplished over less than a fraction of a percent of the continent, nothing of great current value has been reported. The minerals found to date are not in critical demand and would not at present be worth exploitation. I must make clear that, even though it would be difficult to operate mines in the Antarctic, it is technically feasible. Coal has been found in large quantities as close as two to three hundred miles from the Pole. Though not of high quality, it could serve as a local fuel or it could be processed into some of the secondary substances from which plastics and other valuable resins are derived. This might become significant in the distant future.

It is well to remember that exploration for minerals has not been a primary mission of any of the former expeditions and plays no official part in the current IGY program. A few nations such as Australia and U. S. S. R. have included geology in their Antarctic programs. Throughout much of Antarctica, many mountain peaks have been seen and recorded on photographs and maps; however, we have no idea of their geological or mineral composition.

I personally regard the ice itself as being potentially the most important mineral of the Antarctic continent. This tremendous expanse of pure mineral can conceivably be most useful in future manufacture and processing such as in nuclear developments that might require quantities of fresh water and coolants. Corollary to these vast mile thick fields of snow is space. We are rapidly running out of space and testing areas for large scale operations in inhabited regions of the world. In Antarctica there is a tremendous area of space which is not cluttered by civilization, plant or animal life. Indeed, land space may prove a great asset in the future of civilization.

Thinking for the moment of the satellite age into which we are entering, one cannot help but recognize the special value of satellites which will be placed in orbit north-south. Such orbital paths are of special interest because they potentially vertically overlook the entire earth surface and return each time over the earth's poles. The North Pole is a floating and unstable mass of ice. At the South Pole, on the other hand, where the surface is stable, each pass returns over the same spot, offering potential optimum opportunity for data transfer. Even though at the moment we are not necessarily completely agreed upon the eventual value of such a unique observation post, we should not lightly give up our occupational priority to it.

Although the immediate commercial and strategic advantages are not clear, we should not carelessly dispose of the Antarctic. As a nation we have had to face this sort of decision before. Fortunately, we decided correctly in the case of "Seward's folly"—in the purchase of Alaska. However, we made a costly mistake in our national disposition of northern Greenland.

I believe, sir, this completes my statement.

The CHAIRMAN. Mr. Robeson?

Mr. ROBESON. No questions. It was very interesting testimony.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. Dr. Siple, I think that was one of the nicest statements on any subject that I have heard in this committee room. Very comprehensive.

Dr. SIPLE. Thank you, sir.

Mr. TOLLEFSON. You have answered a lot of questions that I might have asked. I do have 2 or 3, however, that you have not touched upon.

As I understand it, representatives of our country have done more exploratory work than those of all other nations combined, outside of the IGY efforts?

Dr. SIPLE. Basically that is correct in respect to geographic exploration. I would not care to support that statement completely when it came to detailed scientific studies such as those made by some of the early German, British, Belgian, and French expeditions. They concentrated on relatively small areas, but they did outstanding scientific work. We have not added as much to the bookshelves of scientific knowledge such as biology, geology, and physicial science as we have to the gross exploration of new territory.

Mr. TOLLEFSON. It was my understanding from items I have read that we have seen better than 75 percent of the Antarctic.

Dr. SIPLE. That is approximately correct, sir.

Mr. TOLLEFSON. And that so far as the other nations are concerned, combined, they have seen only about a third of that amount?

Dr. SIPLE. I am not sure that it is even that much. One big difference has been our pioneering and continued use of aircraft in the Antarctic. This has given us the eyes to see over large areas while explorers of other nations were restricted to what they could see from ships or on limited land travel.

Mr. TOLLEFSON. Now, it is my further understanding that all but this 1 segment of Antarctica which you mentioned earlier has been claimed by some 7 other nations?

Dr. SIPLE. That is correct. Six of the nations claimed unexplored pie-shaped wedges clear to the pole. The Norwegians, over in the African sector, have been more modest by claiming only the coastal region.

Mr. TOLLEFSON. Now, then, that segment which is unclaimed has been viewed almost entirely by the United States, has it not?

Dr. SIPLE. That is true for the region of West Antarctica. However, the inland area, unclaimed by the Norwegians, has, for the most part, not been seen by anyone.

Mr. TOLLEFSON. There is legislation pending, the objective of which is for the United States to claim that unclaimed segment. If the United States did, then the whole of Antarctica would be claimed by somebody, would it not?

Dr. SIPLE. That is correct. But, as I pointed out, if we claimed only what was left over, we would be taking areas no one else wants or can enter because of the lack of ports. Also, as I stated, our most extensive work has been in other than these non-claimed areas.

Mr. TOLLEFSON. The legislation is in two sections. One would lay claim to the unclaimed sector, and the other section provides that in doing so the United States does not waive its possible rights to claim to other portions of Antarctica.

Dr. SIPLE. Yes.

Mr. TOLLEFSON. Now, you said a moment ago that probably from here on in we will have permanent residents down in Antarctica?

Dr. SIPLE. I based that on the observation of the apparent attitudes of other nations who, for at least the last 15 years, have regularly resupplied their stations and give no indication of their intent to leave. The longest occupation without a break has been that of Argentina which has been on Laurie, South Orkney islands for over 50 years.

Mr. TOLLEFSON. Now, it seems that I read somewhere an item to the effect that Russia has said that she would stay there after the International Geophysical Year was over. Have you heard any comments?

Dr. SIPLE. I have no direct information to that effect. One point I failed to elaborate, earlier, was the part played by CASA–GI, the International Antarctic Committee of IGY. This is the parent scientific committeee that recommended the programs in which the United States and other countries have been participating.

A new inter-nation committee has already been formed to continue international cooperation after the official conclusion of IGY this year. This Special Committee for Antarctic Research is going to meet at the Hague in the next few weeks, with the intention of assessing the possibilities of continued research in the Antarctic. There is every reason to believe that representatives of all the countries that participated in the IGY program will attend and that the Soviets will be well represented as usual.

Mr. TOLLEFSON. Now, another question or two with respect to minerals. Is there any reason to believe that a continent of this size would not have minerals in quantity and quality comparable to those on other continents?

Dr. SIPLE. Of course, very valuable minerals have been found on all the other continents. In Antarctica there have been found traces of many valuable minerals and this would lead to the anticipation

of mineral concentrations in the area. We do not know yet, however, over how much of geologic history Antarctica has been glaciated and what effect this has had on scouring off certain secondary mineral deposits. We have proof that in some areas on the continent, subtropical and, at least, temperate conditions did exist at one time. This evidence, in the form of fossils in coal, is certainly not wiped out.

So I believe the answer to your question is "Yes"—that after adequate prospecting, valuable minerals may be discovered.

Mr. TOLLEFSON. Now, one other question. What is the distance between the south end of South America and the northernmost tip of the peninsula?

Dr. SIPLE. About 700 miles.

Mr. TOLLEFSON. You stated there have been enemy craft in those waters. Is it not true that during World War II there was considerable shipping tonnage sunk or captured in that area?

Dr. SIPLE. That is correct. The Germans sank some ships, captured others, including a whole fleet of whalers. The main effect, of course, was the deterrence to allied shipping throughout the whole sector.

Mr. TOLLEFSON. I think that is all, Mr. Chairman.

The CHAIRMAN. Mr. Lennon?

Mr. LENNON. No questions.

The CHAIRMAN. Mr. Allen?

Mr. ALLEN. Mr. Chairman, just out of curiosity, how do you give directions down at the pole? It looks like everything is north, and east is likewise to the right, and around the circle and so forth.

Dr. SIPLE. It is not a simple problem, of course, with everything being north from the pole. Actually, the simplest method is to name directions according to the meridians that we normally think of in the Eastern and Western Hemispheres.

Navigators, flying over the poles now, use the grid system in which they superimpose a mercator chart on top of the polar regions and then speak of direction clockwise by degrees.

After trying a dozen different ways, we finally used the conventional words, north, east, south, and west. East being actually meridian 90° in the Eastern Hemisphere; west, 90° in the Western Hemisphere; zero, north toward London; and south, 180° back toward New Zealand.

Mr. ALLEN. I am afraid I could not catch up to that. [Laughter.]

One other question. Does the occupation by the various countries through IGY stations have any effect on claims to the area occupied, or has there been an agreement that the occupation is not a part of making a claim?

Dr. SIPLE. I believe that a suggestion for a modus vivendi was made by Chile somewhat before IGY began, whereby for a period of time countries occupying or working in the region would make no claims based on current efforts. The suggestion, as far as I know, was not accepted by any other nation.

The IGY countries have carefully avoided the subject of claims and have officially stuck to science. I think that the current period would be a difficult one for us to make conflicting claims lest we interfere with the scientific work being done in cooperation with our IGY partners in the area. If nations, during this IGY period, begin to concentrate on their own interest, it could seriously interfere with

the fine spirit of scientific cooperation now existing. The value of the IGY program is by making possible the complete exchange of scientific data as it is collected at all stations around the world. Anything less than a complete exchange of information would seriously damage the goals of the IGY program.

Perhaps the pre-IGY era might be a safer framework within which to consider claims based on exploration and work in the area.

Mr. ALLEN. Is that the general opinion of all the scientists from both our country and the other countries that are working together?

Dr. SIPLE. I cannot answer for the other countries. I believe it is correct for the English speaking countries. My personal opinion, and I believe that it is shared by the majority of people associated with the IGY program, is that this is no time to upset the present cooperative flow of scientific data.

Many of us when we consider our nationalistic attitude toward the Antarctic, feel that we erred in not doing something about it much earlier when we were operating in the area pretty much by ourselves. I repeat that we should be careful about pressing the issue during the IGY period. Actually, we have done little to strengthen our pre-IGY position. We are doing more intensive scientific work, however, in most of the country we are presently working in, we have at least seen previously.

Mr. ALLEN. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Sheehan?

Mr. SHEEHAN. Mr. Siple, I think I understood you to say that the value of the IGY program is the complete interchange of information among all the nations down there.

Dr. SIPLE. That is correct.

Mr. SHEEHAN. Is that being carried on? Are all nations exchanging all the information they gather?

Dr. SIPLE. It is a bit too early to know whether there has been a hundred percent exchange of information. There is no indication, as far as I know, to the contrary.

Mr. SHEEHAN. That is all.

Dr. SIPLE. Cooperation in the Antarctic with the Soviets and other countries in the daily exchange of weather information, which goes to make up the weather map of the whole Southern Hemisphere, is being carried on very well. We have American personnel at the Russian base and they have representation at Little America.

Mr. TOLLEFSON. Incidentally, are there any women at the Russian base?

Dr. SIPLE. I understand that Russian ships have carried women scientists and stewardesses. They operate their ships a bit differently than we do in that sense. I have been told that somewhere in the neighborhood of 14 stewardesses and 1 to 3 women scientists have made the voyage south in summer. I am unaware, however, if any of them stayed over the winter.

Mr. TOLLEFSON. The thought just occurred to me if a Russian was born there it might strengthen the Russians' position.

Dr. SIPLE. That could introduce an interesting problem.

The CHAIRMAN. Mr. Van Pelt?

Mr. VAN PELT. No questions.

Mr. MAILLIARD. I have no questions.

Mr. PELLY. No questions.
The CHAIRMAN. Mr. Dorn?
Mr. DORN. No questions.
Mr. CURTIN. No questions.
Mr. GLENN. No questions.
The CHAIRMAN. The counsel would like to ask a question.
Mr. DREWRY. Dr. Siple, in considering the advantages of learning about the Antarctic, is it true there, as it is in the Arctic, that the conditions in the Antarctic have a great influence on the weather elsewhere, the weather in the ocean?
Mr. SIPLE. Well, yes. Actually, of course, there are no barriers in the atmosphere to amount to anything that prevents air masses moving around. The primary influence of the air in the Antarctic continent has a bearing on the Southern Hemisphere, but changes in the Southern Hemisphere by chain reaction can also have an equal effect in the North.
However, the most important factor of this is that by knowing what is going on in all parts one can understand the mechanism and therefore come more rapidly to good prognostication for weather right here at home.
In other words, it has a direct bearing, because it is in the science of meteorology we begin to unveil the mechanisms by which the atmosphere works. And we have to go into these regions of great extremes in order to understand. In fact, new areas begin to open up; new mechanisms, that may possibly be working in the atmosphere that we have not given consideration to, have appeared at the pole as one spot. It is still too early to know whether it was real, but at least it appeared there were very interesting phenomena we had not taken consideration of before.
Mr. DREWRY. So what is learned there may very well be of inestimable value in shipping and agriculture and everything else up here in the North American Continent?
Dr. SIPLE. Well, yes. The primary influence of the air in the Antarctic is on the Southern Hemisphere, but by a sort of chain reaction, it can affect the Northern Hemisphere as well. However, the most important factor involves gaining fundamental knowledge in the science of meteorology which will help us unveil the mechanisms by which the atmosphere functions. We have to study these regions of great extremes in order to learn the characteristics of limiting factors. We observed some interesting phenomena at the South Pole that had not been taken into consideration before. It is still too early to know what impact these observations may have. Until we are able to gather and understand the mechanisms of the world-wide atmosphere, we cannot arrive at trustworthy prognostications for weather here at home.
All through this, we must remember the value of basic research and the tremendous fields the applied aspects of this research will effect.
Mr. DREWRY. Is the area down there or any part of it inhabitable to the extent that it could be self-supporting? I mean so that persons staying there could be supported in that environment?
Dr. SIPLE. At present?
Mr. DREWRY. Like the Eskimos did in the Arctic?

Dr. SIPLE. There have been 1 or 2 examples of men having existed in the area for a year at a time by living off the land and even clothing themselves. One could exist in a sense. Although we have had to bring in most of our materials to date, one can look forward to a nuclear age in which reactors could supply heat and power for living, manufacturing, and conceivably help to achieve a partial self-sufficiency. I think it will be a long time before self-sufficiency can be reached.

Mr. DREWRY. Would it be farfetched to think of transporting some of our Alaskan Eskimos to the Antarctic in connection with any work being done down there, on the idea that they would determine how self-sustaining they might be?

Dr. SIPLE. I honestly think we have moved far beyond the premise. We are now in a scientific, atomic age in which we are unveiling the Antarctic through use of airplanes, tractors, and modern scientific techniques. These are technologies more complex than the simple polar arts devised by the Eskimos.

Mr. DREWRY. Now, on the subject of the icebreaker, I think it is clear from your statement that you feel that the proper type of icebreaker—and nuclear power would be advantageous—would be very valuable to this country in working out its further explorations in the Marie Byrd Land sector. Do you have any thoughts in mind as to overall general characteristics of an icebreaker which in your opinion would be the most useful—I mean as to size and power and what types of additional equipment other than icebreaking might be desirable?

Dr. SIPLE. Well, I do not consider myself any authority in the designing of icebreakers. First, as a scientist and an explorer, I can reply to your question, that we have made much progress in the past quarter century in our ability to handle ice. We have gone from the wooden to the metal icebreaker, and from the *Wind* class on to the *Glacier* class. I am not at all certain that we have reached the optimum design of large icebreaker which will permit transit through all major sea ice fields and to further permit cargo vessels to follow safely in its wake.

Secondly, nuclear fuel would permit unlimited and sustained operation. Finally, I would like to make a plea for adequate scientific gear and plenty of cargo hold space. A scientific laboratory would permit scientific studies in the less frequented seas in which icebreakers operate. Icebreakers with extensive cargo carrying capacity would obviate accompanying cargo vessels in some operations.

You will recall that I mentioned that the *North Star* was such an ideal expedition ship because of her ample and accessible holds.

Mr. DREWRY. Part of what I had in mind was the question of cost. Assuming that we are staying in the Antarctic, is it inconceivable that an atomic icebreaker might in the long run—even though they say reactors have not yet been brought to full commercial economic stage—be actually cheaper for use in that area than the total cost of operating down there with traditional ships for reasons such that you mentioned—bringing in fuel if necessary by ship rather than by plane and so on?

Dr. SIPLE. I have very strong convictions in that direction. As I understand it, when one compares present operating costs against the

possible cost of installing and operating a thermal reactor to supply heat, power, and water at the pole station, the nuclear installation would pay for itself in savings within a year or two. However, this area of nuclear energy, costs, and technical equipment is out of my field.

Mr. DREWRY. That is all, Mr. Chairman.

The CHAIRMAN. The committee has the privilege of the House to sit during general debate today. There is a rollcall over in the House now. We will recess for 15 minutes and return to hear Admiral Thomas.

(Whereupon, a recess was taken.)

Mr. DREWRY. Mr. Bonner just called from the floor and said that the situation over there was so hot that we had best recess until 2 o'clock, because they are working on the motion to recommit on the question of increasing the debt limit and the armed services appropriation bill, so there will be at least 2 and possibly more rollcalls.

(Whereupon, at 11:40 a. m., the committee was recessed, to be reconvened at 2 p. m., this date.)

AFTERNOON SESSION

The CHAIRMAN. The committee will come to order.

We will continue the hearing with the testimony of Rear Adm. C. W. Thomas, United States Coast Guard, retired; and tomorrow morning at 9:30 we will have Admiral Richmond and the other Coast Guard officials who may accompany him.

STATEMENT OF REAR ADM. CHARLES W. THOMAS, UNITED STATES COAST GUARD (RETIRED); ADMINISTRATOR OF ARCTIC OPERATIONS OF THE NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR

Admiral THOMAS. Mr. Chairman, I am appearing before this committee as a free agent. I am not reflecting the views of the Coast Guard, nor IGY, nor any other branch of Government. My philosophy is uninhibited by that of higher levels of administration.

The CHAIRMAN. In opening your testimony, Admiral, would you identify yourself? Of course, we understand the past identification, but we would like the present identification.

Admiral THOMAS. I am a rear admiral, United States Coast Guard, retired. I am presently employed by the National Committee for the International Geophysical Year, as administrator of its Arctic operations.

In considering icebreaker tasks, they fall into two different areas: (1) The Polar area, which today implies both Arctic and Antarctic; (2) Your local area, which comprises the Great Lakes and certain rivers. I am not competent to speak of the fresh water ice other than that in the Illinois River, and which has no place before this hearing. My experience is limited almost entirely to polar ice.

In considering the tasks of a polar icebreaker, it is required to provide escort to ice convoys, it is required to break ice at the destination, it is required to furnish certain logistic support at the destination, and also there is a scientific requirement. Now, perhaps the most

important from an immediate standpoint, other than science, is the escort of convoy in ice; and I am going to ask, if I may, that you look at a picture which runs for about 10 minutes. It depicts more clearly than any other I have ever seen, the problems attending trying to get a convoy through sea ice with an inadequate icebreaker. May I have the picture, sir?

The CHAIRMAN. Yes, sir.

Admiral THOMAS. Thank you, sir. This is a commercial picture and we are starting in the middle. It is The Secret Land. I think most of you have probably seen it. This is Operation High Jump.

(Whereupon, the above-mentioned film was shown.)

Admiral THOMAS. In the interests of saving time, I will cut the movie here. The picture gives some idea of the difficulties of trying to get ships through ice with an icebreaker which lacks sufficient length to break a straight track. An icebreaker, in order to provide efficient or effective convoy, must be able to break a straight track and avoid putting hair benders—it is a technical term meaning that you cannot follow the track of the icebreaker from astern if she is knocked off to one side by a hunk of ice and forced to make a radical change of course. The minute that happens, the ship astern cannot follow and she becomes bogged down. The icebreaker has to go back to the tail end of the column and break out each ship in succession, from rear to van, and get them moving, and then jump up ahead and start leading again. That all takes time; and oftentimes, as you saw in this particular movie, it takes as long as days, and even, in the case of High Jump, weeks. Dr. Siple told you this morning that it required 3 weeks for the central group of Task Force to reach Little America. And that figure, to my recollection, is correct.

Also, when she reaches her destination, she must be able to break ice, because you have to cut a channel through the shorefast ice and then into the bay ice in order to effectively offload your vessel. Either that or you must break out the entire bay in order to support an amphibious operation. If, for example, the ice is not thick enough to permit offloading heavy equipment, you then have to get your blasting teams out and blast a channel for your small craft to get the freight ashore.

However, it all takes icebreaking capability, and to cut a straight channel is not sufficient. You have to make it a V-shaped harbor. If you try to cut a straight channel, your prevailing winds are going to choke it with ice because of the Coriolis effect of the movement of ice. In the Northern Hemisphere, sea ice always drifts off to the right of the course of the wind. The reverse is true in the Southern Hemisphere, where it moves to the left. This Coriolis force is a function of latitude and wind velocity, so that, the farther north you are, or the farther south, the greater the angle the ice will move off to the wind, and, also, the greater velocity of the wind the more effective the force. It also can be illustrated by looking at the water going down the drain. You will see it goes down clockwise, and in the Southern Hemisphere it goes counterclockwise. And when you are at the Equator, it goes "plooh."

Then, after you have cleared your harbor or your offloading area, it is necessary to have logistic capabilities in order to support inevitably, in the Antarctic at least, satellite bases or satellite activity. You might be off to support a survey party, or you might be support-

ing a smaller base, or an icebreaker might be even required to establish a beachhead as a vanguard of the main body. So, it is necessary that she have, limited at least, cargo capacity. Of course, the bigger the cargo capacity, consistent with the other requirements, the better.

And, finally, she has to be capable of conducting scientific activity. I shall not go into that because it has been adequately covered by Dr. Siple, by Dr. Reed and, also, Admiral Colbert. However, I cannot overemphasize the importance of knowledge of oceanography, not only in the Arctic but also in the Anarctic.

The icebreaker should also have towing characteristics. She should be able to tow a vessel which is stuck in ice. As you saw in the picture, the *Northland* was able to successfully tow the *Senate*, the submarine, though not until she snubbed her into her towing crotch was she able to make any progress. With a large vessel such as the *Yancey*, such as you saw being taken in tow, she was unsuccessful, because, unless you can get and keep the stem of a towed vessel into the towing crotch, you are not going to get anyplace trying to tow her. Therefore, in the current type of icebreaker—and the same thing applies to the *Glacier*, the Navy icebreaker which I think Admiral Will mentioned the other day—you have to have a larger towing crotch than the present construction allows.

The *Wind* type of icebreaker was built for the Arctic. I think that Admiral Colbert brought that out this morning. That class was not built with a bipolar characteristic in mind. The type is too short to provide efficient towage of vessels in the Antarctic, where you have to have larger ships in order to carry a greater supply because your lines of communication between the United States and Antarctica are lengthened accordingly.

Also, they were not built in sufficient numbers to satisfy current demands for icebreaker support of operations, both in the Arctic and the Antarctic. I served as chief of staff in Deep Freeze I, and as task group commander in Deep Freeze II. The shortage of icebreakers hampered our program. We had to curtail a plan to penetrate the Amundsen Sea, which Dr. Siple mentioned this morning. We had to also curtail a plan of advanced bases around the Antarctic Continent. I shall not attempt to show it to you there, but, if you can see this, from the Amundsen Gulf over here, across to the pole base, and then over to Byrd Base. That would have allowed a very good seismic survey of the continent and gained knowledge of the depth of the ice throughout the planned area. Also, of course, you would have had the other benefits of geological exploration through seismic means.

As Dr. Siple mentioned—I apologize for repeating it, but I think it bears emphasis—the program was also hampered by the fear of an icebreaker being stuck for the winter. Now, the mere fact of an icebreaker being stuck, I think, would be a good thing, from a scientific point of view, but, where you have a number of men on board, such as the Navy icebreakers carry, 12 officers and 197 men in the *Wind* class, you do not have enough food or enough fuel to support that sort of a crew throughout the winter. So, the feeling was that we should not take unnecessary chances with human life.

The supply of bases is another requirement for icebreakers. I think Admiral Will indicated that the requirement of ships in the Arctic goes down with the completion of the project. In the Antarctic we

found that we had to estimate on nearly as many vessels for a resupply expedition as the original effort. For example, the total tonnage of freight being carried down for Deep Freeze III exceeds that of the initial penetration in Deep Freeze I. Deep Freeze II was significantly higher, although that was not only a resupply expedition, but it was also a construction one.

I have been asked to comment not only on the current type of icebreaker, but also on the advantages of the various types. The *Glacier* is a Navy icebreaker which is 311 feet long. I recommended construction of this icebreaker upon conclusion of High Jump, because the *Wind* class was too short and the beam was insufficient to provide adequate support to convoy, particularly of large ships. The *Glacier* type was built longer so that she would be able to steer a straighter track. She was built beamier so she would be able to provide escort for vessels whose beam was at least 75 feet. She does have, incidentally, a 75-foot beam. Her draft is 29 feet. She carries a crew of 228 men and 15 officers.

The *Glacier* has been far more successful in the Antarctic than the *Wind* class because of those characteristics. However, even the *Glacier* has her limit in endurance. She cannot keep the area any longer than 3 months. At least she hasn't been able to during the two expeditions I was with her. However, even that is better than 2½ months' endurance of the *Wind* class.

The advantages of atomic power versus conventional type of propulsion with fossil fuels is another point I have been asked to talk about. The chief advantage of atomic power is, of course, endurance, ability to operate away from your bases. At the present time, we are able to get along in the Antarctic because we have friendly nations in the Southern Hemisphere who are furnishing us with fuel. There is no guaranty that that fuel will be forthcoming indefinitly. The political situation, as you gentlemen know, can change overnight and at least restrict the use of fuel oils in the Southern Hemisphere to the local use of the various states, and deny supply to our Antarctic effort.

The other advantage of nuclear power versus conventional type, I think, comes in ability to get a longer length and a greater beam. I believe that icebreakers should be longer than the *Glacier*. I think that the Russians probably put a great deal of thought and a great deal of study into the characteristics of the *Lenin* which icebreaker is 432½ feet long, has a beam of 90 feet, tonnage of 16,000, horsepower of 44,000, draft of 30 feet. I feel that they figured that would provide them the optimum in the ability of a ship to break ice, to carry a limited amount of freight, and to conduct scientific investigation and, also, to support their northern sea route. I think those things have been brought out as the reason for her construction. I think that anything we build should be along similar lines. Maybe it should be longer. I am not competent to say that it should be any longer or any shorter, but I have been told this; that, after you have reached a point, I think around 350 feet long in an atomic-powered icebreaker, you can add to your length requirements and your beam and draft. In other words, you can put more momentum into that ship without increasing your fuel storage or your personnel requirements. Now, your personnel and fuel storage, of course, become quite

significant when you build up your momentum. It also has, then, that advantage, in addition to endurance.

Of course, too, there is the power requirement for your scientific effort. Some of the disciplines have been mentioned by Dr. Siple and Dr. Reed and Admiral Colbert—disciplines which can be investigated in the Arctic Basin and also in the Antarctic through icebreakers and only through use of icebreakers. So that not only these disciplines but others which were not mentioned would require the production of a great deal of power—power which would be beyond the endurance of conventional fuels to produce. In other words, where you are using a lot of electricity to produce the electronic demands of a lot of disciplines, then you are going into a terrific amount of fuel consumption unless you have some source of fuel which does not require a great deal of space, such as nuclear fuel.

The ability of the atomic vessel to sustain itself would also include the consumption of water. Now, when you take water in the Arctic region, you either take it from an ice floe and pump it on board into your tanks, or you must get out and chop it out in the winter and melt it, or you must use fuel to produce it. And that fuel consumption over a period of time becomes quite significant. On the *Wind* type of icebreaker, we used to use about 10,000 gallons of water a day during wartime, where we had a complement of about 355 officers and men. But even so, we had to go very sparingly, and that was the absolute minimum that would sustain the crew and still keep it clean.

When you consider the *Wind* class of ship is about 14 years old now, and it has been mentioned that the life of a ship is 20 years, you have about 6 more years of expectancy to the life of a *Wind* ship. It is going to take, to build a new ship, about 3 years to get her planned and at least 3 years to produce the vessel. Also, you are going to have to iron out the bugs, and that is going to take a little time, say 3 years. In other words, you are producing a prototype upon which to base a class. Now, the prototype would be the pioneer, or you might say the guinea pig, because there are bound to be some bugs in all construction. But it can be, as was the case with the *Wind* class, a successful implement right off the bat.

So that in planning for the requirements of an icebreaker, I do not think we should focus our attention upon what the needs are today. I think that would be a very shortsighted policy. I think we have to project our imaginations into what are going to be the requirements we will say 10 or 15 years from now. We can draw upon some of the testimony or some of the statements which have been made before this committee by other speakers. For example, Dr. Siple thinks that we are in the Antarctic to stay. I agree with him. I think most people do agree with him. In which case, we are going to have to have icebreaker services, no matter to what degree we are there. And he thinks, and I agree, that it is going to expand. Therefore, that makes even more valid the requirement of an icebreaker with sufficient endurance to support any efforts we have in that region.

Also, we have to consider the northward trend of the airlines. We have the air routes continually pushing northward, traversing the shortest distance between two points along the great circle routes, which in a good many cases pass right over the pole. I think that any icebreaker built should be able to support that by being able to

get within at least helicopter range of any plane disaster. I do not think that you can rely entirely upon wheeled aircraft to be able to get to a scene where a plane has been forced down, and effect rescue. That can best be done by a vessel, providing the vessel has the capability of reaching that point.

I think Admiral Will stated that there will be a commercial effort in the support of DEW line, and that engenders, I think, further commercial efforts in the Arctic. There is no doubt but that the Arctic resources will have to be exploited as Dr. Reed indicated, and there is no doubt that transportation would enable us to get at the resources of the Arctic and also the Antarctic, and that unless transportation has a reasonable assurance of support by icebreakers, I don't think that we are going to get very far. We have to be able to support that transportation effort with a ship which is adequate to the task.

I think that Mr. Drewry this morning asked a question about Eskimos, and Dr. Siple's answer was that we were in an atomic age. In line with Mr. Tollefson's questioning of Dr. Siple, if we are going to make any claims in the Antarctic, I think we should have a very valid reason; and I cannot think of any more valid reason for claims than having citizens living on the continent with an intent to make it their home; to having, as I think you mentioned this morning, Mr. Tollefson, babies born there. That is, I think, the most valid basis you can get for any claim. So I personally do not think the idea of planting Eskimos down there is too farfetched. As a matter of fact, I proposed it to Admiral Dufek repeatedly so he could take it over to OCB and perhaps bring it about, but I don't think he ever took me too seriously. However, as I said before, it is not too farfetched.

In considering wartime requirements—I think I am slightly offbase when I do mention this, and Admiral Richmond certainly is in a better position to do so than myself—but my idea of what is going to happen is transportation of personnel, of freight, of missiles, and aircraft underseas. As a matter of fact, I proposed that in an article I wrote in 1950, but the idea apparently did not catch on. However, I think that we are going to have to come to that someday. And if you are operating submarines beneath the ice, you have to have some kind of surface support for them; and a submarine cannot tow another submarine or effect a rescue of another submarine below the ice, any more than I think that a plane can tow a plane. So that engenders a wartime requirement for an icebreaker.

Also in the same article, I proposed that we think in terms of establishing advanced bases on sea ice, sea ice which would be, maybe in the case of an Arctic war, closer to the shores of the enemy, from which to deliver short jabs which I think are more effective than long-range slugging. And that sort of an operation would certainly require icebreaker support.

Well, I think I could go on and on, but I do not want to bore you. I would prefer to leave such discussion to people better qualified than myself.

I think that in planning for an icebreaker as a general thing we should look to the future and build for the future rather than build for the past. I think that 1 *Lenin* would be perhaps better than 8 or 10 *Wind*-class icebreakers in effective operations. Well, let me put it this way: There is a possibility that there may someday be a war, and there

is a possibility that that war will certainly have an Arctic character; and I cannot think of any more important vessel to build for the Arctic theater than an icebreaker. And I cannot think of any more effective power than nuclear power.

That concludes my statement.

The CHAIRMAN. Now, just a short while ago, the Saturday Evening Post carried an article on the adventure of the *Nautilus* under the Arctic icepack, and you had a submarine in this expedition to the Antarctic.

Admiral THOMAS. Yes, sir.

The CHAIRMAN. And in talking with a member of the Atomic Energy Joint Committee he made the observation that an atomic submarine could surface from under the icepack through efforts of its own and carry on the expeditions that are now underway in both the Arctic and Antarctic. What is your observation on nuclear-powered submarines taking the place of the necessity for icebreakers? I want to get this in the record.

Admiral THOMAS. As I said before, Mr. Chairman, you have to have something on the surface which can support an underseas craft, in case that underseas craft were unable to surface from beneath the ice. Now, I think that the situation depends upon where you are going to surface and the condition of the sea ice. For instance, if you try to blast a hole through sea ice, unless you have a very powerful explosive, I would say, atomic substance, it is not too successful. You can blast sea ice as long as you are near the periphery of that ice. But if you go out to the middle of the fjord and try to blast a hole, it is not too easy. And, in any event, it seems to me you would have to have surface support at the destination; and to get to the destination you would have to have an icebreaker.

The CHAIRMAN. For what purpose did you take the submarine on the Antarctic expedition?

Admiral THOMAS. That was to experiment with the use of the ability of the submarine to, as I understand it, navigate underneath the ice. However, the submarine never did submerge while she was in the pack.

The CHAIRMAN. Although the *Nautilus* may conduct a voyage under the ice, there would not be pools that it could surface in, in the Arctic, only in certain seasons?

Admiral THOMAS. There is an old adage, Mr. Chairman, that ice is where you find it.

The CHAIRMAN. I have been reading your book. [Laughter.]

Admiral THOMAS. Thank you, sir. But you might find an open pool where you want it, and again you might not. You might find the sea frozen solid for thousands of square miles. On the other hand, you might find open water at the pole.

The CHAIRMAN. Would the nuclear submarine be able to carry on, under the Arctic and Antarctic regions, the scientific experiments that we desire, without the aid of icebreakers?

Admiral THOMAS. The atomic submarines?

The CHAIRMAN. Yes, sir.

Admiral THOMAS. I don't think so, Mr. Chairman.

The CHAIRMAN. Has there been any discussion of anything of that kind by scientific people?

Admiral THOMAS. Not the use of the atomic submarine. I have not heard of such a discussion.

The CHAIRMAN. Would you know where we could find witnesses that would be as near expert as possible along this line to testify before us?

Admiral THOMAS. I would suggest the Office of Naval Research.

The CHAIRMAN. When we had the legislation with respect to atomic cargo and passenger ships, we ran into expert testimony from other Members of Congress on the submarine, so I was merely trying to lay the groundwork to prepare an answer here, if we had the same experience.

Admiral THOMAS. Yes, sir. As far as has come to the attention of IGY, nothing has been made available to us.

The CHAIRMAN. The International——

Admiral THOMAS. The International Geophysical Year.

The CHAIRMAN. And as far as combined associates of this International Geophysical Year study are concerned, they know nothing about using the nuclear submarine to carry out their studies and experiments.

Admiral THOMAS. Well, we have not been furnished any information as to the results of the *Nautilus* trip underneath the ice.

The CHAIRMAN. Is it being used for that purpose?

Admiral THOMAS. I understand that there is a scientific use. I do not know the nature of it.

The CHAIRMAN. And in the voyage of the *Nautilus* under the Arctic, there were scientific experiments made at that time?

Admiral THOMAS. It is hearsay on my part.

The CHAIRMAN. Yes.

Mr. Garmatz, do you have any questions?

Mr. GARMATZ. No thanks.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. One of the functions of an icebreaker, as I understand it, is to break a way through the ice for supply ships; is that the chief function?

Admiral THOMAS. Yes, sir; that is one function.

Mr. TOLLEFSON. Well, I am leading up to—could a submarine be an icebreaker and function in that capacity?

Admiral THOMAS. No, sir; she could not be effective as an icebreaker and submarine both.

Mr. TOLLEFSON. You mentioned earlier in your testimony that there was a terrific amount of supplies carried by the supply ships in connection with our activities down in the Antarctic. Do you have any idea of the percentage of cargo that was comprised of petroleum products?

Admiral THOMAS. Yes; in overall cargo requirements, petroleum was 60 percent. That included the bulk petroleum as well as all other, petroleum for aviation and all other activities.

Mr. TOLLEFSON. The thought has occurred to me that an atomic-powered icebreaker could carry supplies, including petroleum supplies, that normally might be carried by the ship that was breaking the way for her.

Admiral THOMAS. She can. She has that capability. As a matter of fact, I should have mentioned an icebreaker has what we call heeling tanks, which permit the ship to ballast down for icebreaking opera-

tions or for operations in ice. And by use of those heeling tanks, emptying one and filling the other, she can rock herself and, in so rocking herself, she relieves the tension of ice on her forefoot when she is stuck. So you are able to rock your way through a sticky situation. Now, oftentimes the icebreakers use the heeling tanks for carrying an additional supply of fuel oil. Icebreaker skippers do not like to do that, but it has been done, and done to good advantage.

Mr. TOLLEFSON. If the United States should decide to remain in the Antarctic after the International Geophysical Year, would that bring about a greater need for an atomic icebreaker than might presently be the case, or might be the case if we did not stay down there permanently?

Admiral THOMAS. If we did not stay down in the Antarctic, there would be no long-range requirement for an atomic icebreaker for the Antarctic. I still think that there would remain the atomic requirement for the Arctic.

Mr. TOLLEFSON. There is an old saying about possession being nine points of the law. If, for instance, the Russians should, after the IGY, decide to stay there and occupy a portion of Antarctica, that would then strengthen whatever claim she might want to lay thereafter to some portion of Antarctica. But, further than that, would it not be difficult to displace somebody that is occupying a given area down in the Antarctic?

Admiral THOMAS. Yes; indeed.

Mr. TOLLEFSON. It would be pretty hard to get them out, would it not?

Admiral THOMAS. Yes; in the case of the Russians, I think you would have to do it by force; and I do not think anybody would want to go to that extreme.

Mr. TOLLEFSON. And if we should decide to stay down there, it would be likewise pretty hard to get us out.

Admiral THOMAS. That is right.

Mr. TOLLEFSON. Of course, this is not a bill on laying claim to Antarctica; but if we were to stay down there, then an atomic icebreaker would become not only very important but perhaps very necessary.

Admiral THOMAS. I agree.

Mr. TOLLEFSON. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. No questions.

The CHAIRMAN. Mr. Allen?

Mr. ALLEN. On the continent of Antarctica, what is the diameter of living?

Admiral THOMAS. Well, in area, Mr. Allen, it is about the size of the United States and Europe combined.

Mr. ALLEN. And just judging by the map, it must be about 4,000 miles in every direction.

Admiral THOMAS. Well, to give you an idea, from the point of water nearest the pole to the pole, is about 700 miles, a little over. So using that as a yardstick, you can see the vast distances involved in the geography of the continent.

Mr. ALLEN. One other question. What is the average depth or the thickness of the Arctic icecap which you might expect to find?

Admiral THOMAS. Of the Antarctic?

Mr. ALLEN. Of the Arctic.

Admiral THOMAS. The Greenland icecap?

Mr. ALLEN. Of the North Arctic generally, around the North Pole.

Admiral THOMAS. I don't understand you, sir. Do you mean the depth of sea ice or glacial ice on land?

Mr. ALLEN. The depth of sea ice that is floating.

Admiral THOMAS. The depth of sea ice can range as high as 30 or 40 feet in the Arctic.

Mr. ALLEN. That would be about as much as you should expect?

Admiral THOMAS. In the Antarctic it ranges a little higher. The Antarctic has a remarkable morphological rate. I have observed it to grow to a depth of 12 feet in 1 year. The year before last, I went into Hallett Inlet in which our Hallett base which Dr. Siple mentioned this morning was located, and the bay was ice free. The following year I went in there—that was 1957—and put in a base, and the ice at that time was as deep as 12 feet.

Mr. ALLEN. Thank you.

The CHAIRMAN. Mr. Bartlett?

Mr. BARTLETT. No questions.

The CHAIRMAN. Mr. Mailliard?

Mr. MAILLIARD. Is there any place in the Antarctic that isn't covered with ice at any season of the Antarctic year?

Admiral THOMAS. Yes, there are several places where it is not glaciated, but that is around the periphery of the continent; notably, in Wilkes Land where we have established a base, is a group of peninsulas which have been exposed as a result of the ice retreating; and also at McMurdo Sound there is a nonglaciated area.

Mr. MAILLIARD. Does anything grow there?

Admiral THOMAS. Lichens and mosses are the only vegetation; algae in the pools.

Mr. MAILLIARD. During what length of period is that land exposed?

Admiral THOMAS. It is exposed most of the year. While you have snowfall, wind action keeps the area pretty well swept.

Mr. MAILLIARD. How broad in length would the land itself be? That is, exposed, nonglaciated as you put it.

Admiral THOMAS. Along Wilkes Land, the maximum is about 4 miles—4 miles from the barrier to the water's edge. At Cape Hallett you have an area which would be about a half mile at the entrance.

Mr. MAILLIARD. Who now occupies the land that is nonglaciated? What country?

Admiral THOMAS. The United States, for one; Australia, Russians, the New Zealanders. In the Palmer Peninsula, the Argentines, the Chileans, the British; and I do not know whether the land which the Japanese are occupying is glaciated or not. The Norwegians, I think, are in a glaciated area.

Mr. MAILLIARD. Has the experience been that the area is constantly widening, the land area that is not glaciated?

Admiral THOMAS. I do not know, Mr. Mailliard. I do not think anybody knows. That is one of the studies underway. The preponderance of opinion, as I gather from a Russian scientific report, is that since 1940 the earth has been getting colder, we are passing into a cycle of colder weather. It is also believed that, up until 1790, the

earth was getting colder; and then since that time, there was a warming trend which, according to the Russians, terminated in 1940.

Mr. MILLER. Excuse me. What was the length of that cycle?

Admiral THOMAS. The cycle?

Mr. MILLER. From the cold to the heat and back to the cold again.

Admiral THOMAS. Sir?

Mr. MILLER. What is the estimated length?

Admiral THOMAS. From 1790 until 1940.

Mr. MILLER. Well, that would be about 150 years. Now, is it turning back again?

Admiral THOMAS. According to this Russian report, it is getting colder.

Mr. MILLER. Some of our people estimate that it is about 1,800 years?

Admiral THOMAS. Our estimate is that about—well, let's start with the termination of the Wisconsin Glacial Age, which was about 20,000 years ago. Then there was a period of warming climates until about 5,000 years ago. And then the trend began toward harshening climates, and the amelioration of climates in 1790 is believed by some to be a cycle within a cycle.

Mr. MILLER. Well, my only authority, as I remember it, Rachel Carson in her book, The Sea Around Us, depicts the cycle as about 1,800 years. Now, maybe that is another cycle in that cycle.

Admiral THOMAS. Yes, I think that there is probably a cycle within a cycle there. We know that the Norsemen were able to get over to Greenland in their Viking craft, and sometimes it takes an icebreaker to get in some of the places where they penetrated. Particularly East Greenland, they established a colony named Angmagssalik; and today, at the time of year they went in, it takes an icebreaker.

Mr. BARTLETT. Mr. Chairman, may I ask one question?

The CHAIRMAN. Yes, sir.

Mr. BARTLETT. Admiral, the Coast Guard has the general duty of inspecting ships; and before long, in all probability, it will have to inspect atomic-powered commercial ships. Now, would it not be a tremendous advantage to the Coast Guard, first, to have a ship of its own of that character? Would not the Coast Guard task be easier by reason of that fact?

Admiral THOMAS. I should think so, sir. I think Admiral Richmond is more competent to answer your question, but it stands to reason that a laboratory, you might say, in which to train inspectors would certainly be advantageous.

Mr. BARTLETT. Thank you.

The CHAIRMAN. Now, Mr. Drewry has a question.

Mr. DREWRY. Admiral, you spoke of the need for an icebreaker with bipolar characteristics; and as I understood your part, at least one element of that was that we needed a vessel with longer range and greater size for the Antarctic, and that it could also be used in the Arctic. You also mention the 30-foot draft of the *Lenin*—you mentioned that the *Lenin* has a 30-foot draft. Is that 30-foot draft possibly too much in some areas of our own Arctic where we might need icebreaking vessels?

Admiral THOMAS. I do not think so.

Mr. DREWRY. I think Admiral Will mentioned that they found a 36-foot depth on the channel, across from west to east, that they could operate in with both surface vessels and submarines. And I wondered on our own Arctic coast, in order to get to it adequately, whether there might be a need also for shallower draft. Not necessarily nuclear, but——

Admiral THOMAS. I think that one would support the other. It was my experience, in the *Northwind* on the coast of Alaska, which is the Arctic coast, being rather shallow, we were able to accomplish our mission. I must confess that I had my ship aground so frequently that I blushed to draw sea pay, but I did not report it to headquarters and we got along fine.

Mr. DREWRY. Have you ever heard any mention made in recent years of the numbers of icebreakers which we ought to have as a sort of a minimum peacetime and minimum mobilization base?

Admiral THOMAS. I have heard mention over in Fleet Operations, Op 30, when I was with the task force, that they ought to have 8 more icebreakers. That was purely an off-the-record discussion.

Mr. DREWRY. Is it off the record now?

Admiral THOMAS. No, I do not care what you say now. But the question was at that time at this particular—what I might call a "gam" session—whether the Coast Guard should have 4 of the icebreakers and the Navy 4.

Mr. DREWRY. You have been in the icebreaking business for quite a long while, and I believe you were in the Coast Guard concerned with icebreakers at the time the *Wind* class were conceived. Is that correct?

Admiral THOMAS. At the time they were conceived?

Mr. DREWRY. Yes, sir.

Admiral THOMAS. No, Mr. Drewry. I did not enter the ice business until after the war began. These were conceived, I think previous testimony shows, before the United States entered World War II.

Mr. DREWRY. You mentioned the fact that the existing vessels of the *Wind* class are 14 years old.

Admiral THOMAS. That is correct.

Mr. DREWRY. And what I had in mind was: Is it not true that from the standpoint of the design of these vessels that it antedates that 14 years by maybe as much as another 6 to 10 years?

Admiral THOMAS. In planned requirements I think it antedated the construction date by at least 4 years.

Mr. DREWRY. So from a design standpoint it goes back prewar, back before we had these tremendous movements into the Arctic and the Antarctic which we have had during the war and since then?

Admiral THOMAS. That is true.

Mr. DREWRY. There has been a great deal of experience gained in the meantime——

Admiral THOMAS. That is true.

Mr. DREWRY. Which suggests there is much that can be learned from that experience that could be applied to design of any new ship.

Admiral THOMAS. Yes.

Mr. DREWRY. Now, in previous conversation there was one thing that you said that struck my interest, and I would like to ask you about it because we did not pursue it very far.

In this intensive research and scientific work which has gone on, is there any work being done looking toward a method of avoiding the necessity of breaking ice by disintegrating it or anything like that?

Admiral THOMAS. There is no work being done toward the disintegration of sea ice. As a matter of fact, to my knowledge there is no work being done on sea-ice crystallography at all.

Mr. DREWRY. Well, is it a conceivable project? After looking at that film a little while ago I almost decided not to ask the question, because it seemed so overwhelming—the ice as it is. But is it a conceivable project?

Admiral THOMAS. It is. I was interested enough to take a course in crystallography at Johns Hopkins, and I asked my professor the question as to whether or not we would be able to disintegrate the ice molecule, and he said, "Without a doubt."

And, furthermore, you might not only be able to disintegrate the ice molecule but use the products of disintegration in the generation of additional energy.

Mr. DREWRY. But, as you say, it would be well into the future?

Admiral THOMAS. I think so. Probably 25 years.

Mr. DREWRY. So we do not see our way clear to eliminating icebreakers at this stage?

Admiral THOMAS. Not right now.

Mr. DREWRY. Just one more thing. In view of the question raised about research work with submarines, Admiral Colbert handed me a note taken from a Russian publication dated July 1956 entitled "Under-Ice Submarines." It is rather short, and I think it might be interesting to read it into the record. It reads:

> Construction and various peacetime uses and possibilities of atomic-powered submarines are described. It develops construction details should be varied according to the uses planned. For scientific underwater or underice exploration the submarine should have a pair of sleds with shock absorbers attached to the upper deck, ice-melting equipment (acetylene torches), telescopic towers for exit purposes on all sides of the hull, powerful searchlights with adjacent observation ports, a side diver's port, and a large bottom hatchway for lowering a deep-water bathosphere with two men and equipment for oceanographic geophysical investigations.
>
> For rescue and salvage work the submarine should have a special telescopic tube and acetylene torches for tight attachment to the smaller vessel and penetration into its interior.
>
> Many other proposed devices are also discussed.

But July of 1956 is within a rather short period after the first word came out and apparently when the atomic icebreaker of the Russians was started to be built. Do you have any comment in line with Mr. Bonner's question about this information here?

Admiral THOMAS. No, the only comment I have is that I think that before anyone can answer that sort of a question we have to know more about ice. We have to know more about the physical, chemical, biological, and crystallographic properties of sea ice and also its viscoelastic properties.

Mr. DREWRY. As far as you know, you do not see any practical way for——

Admiral THOMAS. For melting from underneath I do not see any practical way. I do not know of its ever having been tried. I do know that we have tried blasting it.

Mr. DREWRY. Obviously, in view of the time on this, the Russians do not feel that the atomic icebreaker is unnecessary or they would not have gone ahead with it at the time they were discussing submarines.

Admiral THOMAS. That is correct.

Mr. DREWRY. I mean the submarine would not be a substitute for the icebreaker.

Admiral THOMAS. It certainly would not vitiate the requirement.

Mr. DREWRY. That is all, Mr. Chairman.

The CHAIRMAN. Any other questions?

Mr. Allen?

Mr. ALLEN. Can the icebreakers that you now conceive of as this future one of ours or the *Lenin* break through all of the average depth of ice in the Arctic? Can it break ice up to 40 feet I believe you mentioned?

Admiral THOMAS. If the ice has someplace to go and if she is able to carry sufficient momentum.

Now, the Russians, I know, from someplace I read it, expect to reach the pole, the North Pole, with their icebreaker. The prospective commanding officer of the icebreaker has always dreamed of reaching the pole. And this newspaper item said that now his dream is about to be realized.

Mr. ALLEN. One other question I would like to ask. That is concerning the tides up there around the polar region. Do they have tides? And if so, how do they run?

Admiral THOMAS. Nobody knows as to the extent of the tides. At least it has not been made available to us that I know of. And it is difficult to determine just how they run.

We know something about the current structure. We know, for example, from the drift of ships, how the currents run, how they behave.

This will illustrate in a way something of the current structure. This is our ice island T–3. We call it "Bravo." And this shows its drift since the time it was first occupied in 1952 and its present position today.

This is our icepack station Alpha. It is not an ice island. It is an ice floe—sea ice. And this is where we occupied it in the spring of 1957. And, as you see, she drifted north and now she is moving south again.

This is the drift of the Russian North Pole station. She actually was occupied here, she drifted over here, and then down to the position where Alpha was last October.

Somebody drew a line here. The Air Force had this chart, and I think that in borrowing it they put a line here, but I do not think it means anything particularly.

This is the Russian North Pole 6. This is where she was first sighted in April of 1956. She was occupied during the summer right here. She drifted here. This is her present position today, or at least it was at the first part of the month.

Mr. ALLEN. We saw a picture of a small tanker on top of a rock the other day. Would that be a tidal action that put it up there?

Admiral THOMAS. Undoubtedly.

Mr. ALLEN. What would you estimate that to be? Thirty, forty feet?

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Admiral THOMAS. Assuming that vessel drew about 23 feet, it must have been around 30 feet.

Mr. ALLEN. Thank you, Mr. Chairman.

The CHAIRMAN. Is the magnetic attraction at the South Pole entirely different from that at the North Pole, or is there any magnetic attraction at the South Pole?

Admiral THOMAS. The south magnetic pole is not congruous with the south geographical pole. Actually, the south magnetic pole is in——

The CHAIRMAN. Is there a magnetic attraction at the South Pole?

Admiral THOMAS. Yes.

The CHAIRMAN. I am just trying to get it so I understand it.

Admiral THOMAS. Yes; the earth is a magnet.

The CHAIRMAN. When you get in that area, do you then shift compass bearings from the North Pole, or do you go right on with the North Pole compass?

Admiral THOMAS. We use gyro compasses, and it always points true north, and we take our bearings relative to that true north reference.

The CHAIRMAN. There is no utilization made of any magnetic attraction by compass at the Antarctic?

Admiral THOMAS. No; except when you are using a magnetic compass it is very unreliable when you reach theose latitudes. So if you do not have a gyrocompass you use an astrocompass or some compass which will measure the angle of a known heavenly body.

The CHAIRMAN. Any further questions?

Our friend, former distinguished member of this committee, would like to ask a question.

Mr. SHELLEY. Admiral, the same thing is true in the extreme northern latitude as far as the variation on the magnetic bearing too?

Admiral THOMAS. That is correct, Mr. Shelley.

The CHAIRMAN. Are there any other questions you would like to ask on the icebreaker business?

Mr. SHELLEY. No, thank you, Mr. Chairman.

The CHAIRMAN. If there are no further questions, the committee stands adjourned until tomorrow morning at 9:30.

(Whereupon, at 3:30 p. m., the committee was recessed, to be reconvened at 9:30 a. m., Friday, January 24, 1958.)

(Article, Our Vulnerable Flank, by Adm. Charles W. Thomas, published in U. S. Naval Institute Proceedings, February 1951, follows.)

OUR VULNERABLE FLANK

(By Capt. Charles W. Thomas,[1] United States Coast Guard)

When ancient Greece was threatened by invasion from Persia, the Athenians sought counsel of the Delphic oracle, who prophesied the safety of Athens lay in "wooden walls."

"Your ships are the wooden walls," Themistocles declared, as he interpreted the oracle's cryptic words.

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[1] Graduated from the U. S. Coast Guard Academy in the class of 1925. Captain Thomas has had extensive service in icebreakers. During World War II he commanded the *Northland* on the northeast Greenland patrol and, while commanding the *Eastwind*, captured the German weather and radio station on North Little Kaldeway Island and the German naval transport *Externesteizne* (now U. S. *Callo*). He commanded the *Northwind* during Operation High Jump in 1946–47. At present he is Chief of Staff, Second Coast Guard District, with headquarters at St. Louis, Mo.

When, at length, the Persian horde swept over northern Greece, the Greek fleet dogged by the Persian fleet was used to cover the flank of the Greek Army as it retreated southward before Xerxes' advance. At Salamis, the Athenian armada, with its back to the wall, engaged and defeated the Persian fleet. With his flank thus exposed and logistic support denied his army, Xerxes had no choice but to retreat. The power of the great Persian empire was broken.

Today, as it it was in Athens in 450 B. C., the strength of the nation lies in her wooden walls. Today, our wooden walls require multifarious specialized implements, including naval aviation. Our wooden walls must be global in character, capable of being thrust out to cover any flank and supporting an offensive operation wherever there is sea water. Any geographical voids in their radius of activity are certain to be exploited by the enemy, if at all accessible to him.

The Bible story of David and Goliath (I Samuel 17) is a simple but cogent lesson in strategy. This classic tells how Saul girded David with armor in which to meet the heavily armed Philistine giant, Goliath. It shows David, casting off his armor, picking up his staff, and fighting Goliath with his sling and five smooth stones carried in a shepherd's bag.

The manner in which David slew Goliath is a sermon on the triumph of mobility with a punch over cumbersome armament and heavy weapons. It has been accented by the pageant of history—the mighty walls of Rome, the great wall of China, the innumerable fortress cities of Europe, and more recently the Maginot Line. All were invincible. Yet, all were shattered by the momentum of mobile forces directed at a weak point.

Our modern concept of mobility connotes a chain of operational and logistic support from basic source to points of contact with the enemy. It envisions getting as close as possible to the enemy to deal short powerful punches. It provides heavy support to the initial striking force, which is comprised of lightly armed troops, light motorized equipment, and packaged supplies transported to neutralized zones in fast transport aircraft with fighter escort.

To satisfy global requirements of mobility we must be able to push our wooden walls into the polar seas as well as elsewhere. We must be able to set up and support advanced bases in the Arctic wastes, on the ice if necessary. This, we are not presently prepared to do.

The maritime borders of the U. S. S. R. measure a distance of 24,844 statute miles. Many ports on this vast coastline are not served by railroads, and periodical freezing disrupts their normal economic life.

In the east, ice covers the northern part of the Sea of Japan and the coastal area of the Okhotsk and Bering Seas. The same condition is true of the Finnish Gulf. Russia's northern ports on the Sea of Azov and Black Sea are frozen during the winter months. It follows that her northern ports on the Arctic Ocean and contiguous seas are similarly denied, with the lone exception of Murmansk—the only year-round open port.

Because of the character of Russia's seaboard, she requires an ice-worthy merchant fleet with icebreaker support to serve intrastate economic demands. The men (and women) who man her ships are experienced ice-seamen. Likewise, her naval forces, army, and airforce are adapted to and trained in, Arctic operations.

It is clear that in the event of hostilities between the United States and Russia, the war would not be without an Arctic character. Moreover, because of the totalitarian nature of the Soviet Government, the U. S. S. R. would have the advantage of initiative in the early phases of such a war. Russia might, therefore, be expected to strike in a theater we are least prepared to defend—our Arctic flank.

For example, by a series of lightning-like thrusts, Russia might readily occupy such stepping stones as Spitzbergen, Jan Mayen, Greenland, Iceland and Northern Canada. Then, from base to base, across frozen seas, our enemy could pour his heavy support of troops and war materials. An operation of this nature would threaten our western European allies. It would pin their manpower to the homeland. It would seriously hamper our communications with Great Britain. It would place the enemy athwart our northern flank.

It is not alone sufficient that the United States avail herself or her allies of air bases in the Arctic (and there is an abundance of natural fields in these regions). What is more important, she must be able to bring surface support to these places.

Operations in the Arctic (or Antarctic), where there is sea ice, require vessels of special ice-worthy construction, if mobility is to be achieved.

There are many types of naval vessels which do not lend themselves to basic changes in design to suit ice conditions. Some of these are—large carriers, battleships, cruisers, destroyers, submarine chasers, torpedo craft, and mine layers (which nature rules out). But there are other types whose purpose requires universal employment, which can be constructed for ice navigation.

The type of vessel most fundamental to naval operations anywhere is the transport—for personnel, supplies, and fuel. The Navy has tried, and actually used in ice, vessels of this type which are built on conventional scantlings and strengthened for polar operations. But they have proved vulnerable to damage, nonmaneuverable, and expensive to operate. They have failed to satisfy the requirement of mobility in areas of sea ice.

Effective mobility demands the following prerequisites in naval construction for ice transport: (1) Maneuverability, (2) ice-worthiness, (3) economy of operation, (4) relative small size, and (5) quantity in number of vessels available.

To satisfy qualities of maneuverability, iceworthiness, and economy, transport vessels must embody the following characteristics of design: Short length (not over 300 feet), broad beam, deep draft, thick shell plating, heavy members, close frame spacing, horizontal stiffening, adequate compartmentation, and be self-drydocking (ability to rise with ice pressure). Machinery must be of relatively low power in order to provide pay-load capacity.

As implements of war become more and more devastating, two old Arctic adages become increasingly emphatic. These are: (1) Take into the Arctic what you think you will need and add 50 percent to it. (2) If possible, never put all the eggs in one basket. The latter consideration, in addition to maneuverability, demands vessels be small in size and, consequently, many in number. When setting up estimates of requirements, it is essential that the 50 percent additional capacity for Arctic operations be provided. Hence, the overall number of vessels is increased accordingly.

An important advantage inherent in ships built for ice navigation is their utility in other areas. An iceworthy transport can be operated in the Tropics with consistent economy. There would be no necessity, therefore, for placing the bulk of hundreds of vessels of this type required for wartime use in mothballs during peacetime. Vessels over and above the requirements for training may be deployed among forces operating in ice-free waters. Or, they may even be leased to private operators. Experience has shown that, in general, smaller ships are a better financial risk than large liners.

From a point of view of longevity, cargo carriers are a sound investment. A workship can be useful for years, while a bombing plane soon becomes obsolete. Ships built for World War I are still making money for their operators. Planes of contemporary vintage have long since been fit only for museums.

An iceworthy vessel is not essentially an icebreaking vessel. Operation of iceworthy vessels in frozen seas needs icebreaker support. The Russians have tried icebreaking cargo ships, but had to stop using them when it became apparent machinery demands produced diminishing payload returns. Hence, the convoy system with icebreaker escort produces the optimum of efficiency in ice-transport. The allocation of ice-breakers to convoys varies with the character of the theater, but a reasonable overall ratio appears to be one heavy icebreaker to four ships of other types proposed for Arctic employment.

The *Wind* type of heavy icebreaker is the most effective ever built. But there is room for improvement in basic technique, which, if implemented, would reduce the number of icebreakers needed. We should learn how to disintegrate or melt ice. How? The answer is for science to determine. One idea suggests itself. During World War II, ships of the Northeast Greenland Task Unit sometimes used steam or warm water to drill in ice preparatory to blasting out of a pinch. Of course, steam is too precious for large scale disintegration, but the application of temperature or mechanical abrasion is not fantastic.

Here again, it is pointed out that icebreakers can play an important role with the fleet wherever it may be during periods of non-Arctic employment. They are better adapted to general salvage [2] and towage [3] than any other type of vessel.

In 1930, Sir Hubert Wilkins' abortive attempt to reach the pole by navigating a submarine beneath the ice was hailed as "fantastic." But during World War

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[2] The icebreaker *Westwind* was slated for assignment to the Pacific Fleet as salvage vessel. Her transfer to the Russians under lend-lease prevented this allocation.

[3] The icebreaker *Northwind* towed the *AKA Merrick* at 13.5 knots over the bottom during Operation High-Jump.

II, a German submarine navigated beneath 100 miles of northeast Greenland pack ice to support a Nazi ice-worthy transport. The use of the submarine by the enemy as well as ourselves is a weapon to be reckoned on in Arctic theaters in a future war. It is necessary that we develop underseas craft to include troop carrying, cargo carrying, and even plane carrying characteristics in under-ice operation.

Obviously, a fixed wing airplane cannot be expected to land on the deck of a submarine, but sea ice and even glacial ice lends itself to adaptation for use as a landing strip for small aircraft.

By contemporary standards, the carrier task force is probably the most potent naval weapon ever developed. Moreover, an appraisal of ship casualties inflicted by and upon the Japanese Navy during the recent war shows clearly the majority proceeded from carrier-borne aircraft. The adaptation of carrier characteristics to operation in sea ice should be considered. Because of requirements of maneuverability and iceworthiness, aircraft carrier design to suit Arctic conditions must be radically changed. Concurrent changes in aircraft types are likewise necessary in order to permit landing and takeoff in a restricted space.

Perhaps there are other types of vessels which could be well utilized in sea ice. The field of research in laying a basis for and developing ship design is one which must be encouraged at all costs. We must first have an abundance of geophysical information. We must know more about the physical and chemical properties of the ice we propose to navigate. And we must know more about the dynamics of the water beneath sea ice.

For example, water heated at the Equator is transported to the poles in the upper layers and returned to the equatorial regions in lower layers. So nature makes a tremendous amount of energy available to the polar seas. Energy in any form represents a potential in work. The manner in which conversion of energy is to be accomplished is but one of the many secrets for science to unlock. Perhaps energy of this nature may be used to heat, to propel a ship, or even disintegrate the ice in her track.

Geophysical research prerequisite to improved technical developments is a task of the Office of Naval Research. It is science which makes possible the ultimate objective of a belligerent power—the invasion of the enemy's homeland. The work of the Office of Naval Research must receive the full support of both legislative and executive branches of government. It all comes under the heading of getting in close to deliver the punch.

It took science thousands of years to develop the sling with which David felled Goliath. But without skillful application of the weapon in the hands of David, it could not have prevailed against the giant's heavy armor.

We may build hundreds of iceworthy auxiliary vessels and provide air, submarine, and icebreaker support. But unless our people know how to use them, they will never deliver the goods with which to deal devastating blows at the enemy. The importance of training personnel to cope with problems peculiar to Arctic warfare, ice seamanship, and survival in the theater is apparent.

In the polar regions, nature is harsh. Regardless of the imminence of enemy action, man is constantly at war with the elements. The acme of intra- and inter-ship teamwork is required at all times. Hence, the highest order of discipline is essential because discipline always manifests itself when the going becomes tough. And in the Arctic the going may generally be relied upon to be tough.

Discipline cannot stand alone. It must be augmented by skill, and skill comes only with experience. Every element of the team, from admiral to nonrated man, must be able to handle any problem within the scope of his task, in sea ice. For example, the force or group commander must be able to evaluate ice conditions in making his estimate of the situation, and thus deploy his forces with the maximum effect. The unit commander must know how to cope with the ice in his immediate operating purview, and the officer of the deck, how to take care of the situation within his visible range. Crew members of the blast detail of the watch, for instance, must know where to place charges and how deep to lower them.

Training in ice seamanship will not only inculcate skill through experience. It will also emphasize the importance of discipline to all levels of organization. There is a tendency, inherent in man, to fear ice—whether sea ice or glacial ice. Training will teach naval personnel that ice is to be respected rather than feared.

In large-scale movements in ice, officers and men throughout the organization soon learn to rely upon the skill and judgment of their subordinates. And those

subordinates learn to step into the task of their immediate superiors. Hence, there is no better training ground for self-reliance and the exercise of initiative. Moreover, there is nowhere good seamanship more necessary or in more constant use.

Training for Arctic operations is just as essential to ground and air forces as it is to ships' personnel. The entire military team must coordinate its task as carefully as the ships of a single task unit.

Discipline connotes a normal continuing activity. It integrates courtesies, precision, and the innumerable intangibles peculiar to military life. It costs nothing. But training, like ship construction, demands the expenditures of large sums of public funds. Hence, training for warfare, in a theater as little understood as the polar seas, is likely to be unpopular.

Rear Adm. Richard E. Byrd, United States Navy (retired), has dedicated his career to proving that American enterprise and ingenuity can overcome obstacles imposed by ice and frigid weather, to showing that icy wastes may be utilized to military advantage, to blazing a trail in the development of an American polar economy. He has spent the greater part of his life trying to make the United States strong on its weak flank.

Another large-scale Antarctic operation, such as Admiral Byrd advocates, would serve a multifold purpose. It would unearth a wealth of scientific information so necessary to military and economic progress. It would enable research engineers to evaluate changes in design of ships so essential to the security of our polar flanks. It would teach us more about survival and ability to live and fight under polar conditions. And, notwithstanding the inadequacy of conventional transport construction to cope with sea ice, it would provide our fleet a measure of training so vital to its wartime mission. Finally, it would bring the untold wealth of resources in the Antarctic Continent closer to the peace-loving nations of the world.

We must excel Russia in Arctic mobility. Unless we have ships, men, and war materials which are suitable for covering our polar flank, we are as vulnerable as the Persians at Salamis. Our defense structure must be as strong on the sea as it is in the air. It must be as strong in the north as it is in the middle latitudes.

Our wooden walls must secure the springboards and support offensive operations wherever they may be. They must provide the mobility and the punch to penetrate the enemy's defense armor.

Even as David felled Goliath.

ATOMIC ICEBREAKER

FRIDAY, JANUARY 24, 1958

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D. C.

The committee met, pursuant to call, at 9:30 a. m., in room 217, Old House Office Building, Hon. Herbert C. Bonner, chairman, presiding.

The CHAIRMAN. The committee will come to order.

When these hearings commenced on Wednesday, the Chair called the committee's attention to the fact that we were adopting a somewhat different approach in order that the committee might have the benefit of the best background testimony available to acquaint the members with the nature and scope of our interest in the polar regions, where the proposed icebreaker would be used. The testimony we have received from the five experts who have appeared, together with the graphic presentations made with slides and movies, have, in the thinking of the Chair, given the committee the benefit of excellent briefing.

I only regret that more members of the committee were not present to hear what has been said.

Today, we bring our attention to the proposed legislation itself. There are now before the committee members copies of the three identical bills, "To authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes," together with committee document No. 2, containing the official reports from the Department of the Navy, Treasury Department, Atomic Energy Commission and Department of Commerce.

Our first witness today will be Vice Adm. Alfred C. Richmond, Commandant of the Coast Guard, to be followed by Rear Adm. A. G. Mumma, Chief, Bureau of Ships, Navy Department, and top officials of the Atomic Energy Commission.

Inasmuch as we are anxious to complete these hearings today, I set the time of the meeting for 9:30, and hope that we will be able to hear the witnesses to the full extent necessary, and with their testimony conclude this series of hearings.

For the record, I want to have placed at this point in the record the reports from the various Government agencies.

(For reports referred to see pp. 2–4.)

The CHAIRMAN. Admiral Richmond, we shall be glad to hear from you at this time.

STATEMENT OF VICE ADM. ALFRED C. RICHMOND, COMMANDANT, ACCOMPANIED BY REAR ADM. J. A. HIRSHFIELD, ASSISTANT COMMANDANT, AND REAR ADM. K. K. COWART, ENGINEERING CHIEF, UNITED STATES COAST GUARD

Admiral RICHMOND. Mr. Chairman, I have with me Rear Adm. J. A. Hirshfield, Assistant Commandant of the Coast Guard, and Rear Adm. K. K. Cowart, our Engineering Chief.

The CHAIRMAN. Do you gentlemen care to sit around the table with Admiral Richmond?

Admiral RICHMOND. I shall be glad to have them with me.

Mr. Chairman, I have a prepared statement, and with your permission, I shall proceed.

The CHAIRMAN. Yes, sir.

Admiral RICHMOND. I regret that I was unable to be present Wednesday to hear the testimony given by earlier witnesses on the proposed bills, H. R. 9196 and H. R. 9978, "To authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes." It is my understanding that the bulk of the testimony was generally directed to matters concerning ice conditions encountered in the Arctic and Antarctic, and the general requirements for icebreakers to insure reasonably safe navigation in these areas.

In discussing the bills today, I think it desirable that I first outline as background the experience of the Coast Guard in this general field, with a short résumé of the historical development insofar as the Coast Guard is concerned. I hope, not having heard the previous testimony, that I will not be too repetitious of material that you have already received.

At the outset, I am sure the committee appreciates that the Coast Guard, or its predecessor, the Revenue Cutter Service, has always taken an active participation in exploration of new areas or the opening of new fields of knowledge. The long history of the Coast Guard is replete with instances where the Service was called upon for an active part, both in pushing to new frontiers and in taking emergent action to assist citizens in distress on these frontiers. For example, much of the task of policing and developing Alaska after its purchase from the Russians fell to the Coast Guard. The first cutter to visit Alaska after the purchase was the *Lincoln*, which was dispatched north to carry the flag immediately following ratification of the treaty in 1867.

Much of the early knowledge of the flora and fauna, as well as the geographical exploration of Alaska, can be traced to the work of our predecessors. As early as 1880, the Service extended its Alaskan duty when it inaugurated systematic cruising in the Arctic Ocean. The purpose of the first trip was to search for the famous exploring steamer *Jeannette* and two whalers unreported for many months. In the 1890's, when the food supply of the Alaskan natives had diminished to a point where their existence was threatened, it was the cutters of our Service that procured and carried from Siberia to Alaska some 1,100 reindeer which became the nucleus of the large domesticated herds of today.

In the fall of 1897, when 8 or 10 whaling vessels with nearly 300 men aboard were icebound in the vicinity of Point Barrow, it was the Coast Guard that was called on to go to the relief of the starving crews. Two Coast Guard officers, accompanied by a Public Health Service doctor, made an unprecedented 1,500-mile march across Alaska, in the middle of winter, from Cape Vancouver to Point Barrow, gathering up and driving some 400 herd of reindeer before them for food for the scurvy-wracked men.

This spirit of pioneering has not diminished or died out in the Coast Guard from the days of the events I have just mentioned. Throughout the years we have continued to carry law and order and assistance to those in distress throughout Alaska. In addition, during and since the war the Coast Guard has participated actively in the necessary job of developing our frontiers beyond those of our immediate borders, and as I am sure you learned from the testimony yesterday or Wednesday, we have been active partners in the exploration and development in Greenland, as well as doing our part in the exploration and construction of the Dew line stations. We are very proud of the accomplishment of the tenders *Storis*, *Spar*, and *Bramble* this year, not only in completing the Northwest Passage, but in being the first United States vessels to circumnavigate the North American continent. We have had an active part both in the preparation for and in carrying out the present Geophysical Year operations in the Antarctic, as well as the earlier operation in the Antarctic under Admiral Byrd.

I mention these things, not for the purpose of boasting, though I naturally take justfiable pride in these accomplishments of the Coast Guard, but for the purpose of emphasizing to this committee that the Coast Guard has a long record of participation in pioneering ventures, and that the spirit that men take with them into these undertakings is as alive in the service today as ever. In summary, this proves that there is nothing in H. R. 9196 and H. R. 9978 which would be novel or unusual to the Coast Guard except that it suggests a new and different source of power for the contemplated icebreaker, which power in itself is barely in the exploratory or pioneering stage.

I would now like to discuss the development, not only of icebreakers in the United States, but of the knowledge of operation in ice as well. I am sure that you have heard that 25 to 30 years ago the word "icebreaker" as applied to a specialized vessel would hardly have been recognized in this country. The reasons, of course, are obvious. The United States had no boundaries where it was necessary to keep harbors or sea lanes free of ice. True, the Coast Guard had for a number of years operated a cutter, the *Bear*, which became famous for her many trips to Alaska as far north annually as Point Barrow. However, in the true sense of the word the *Bear* was not an icebreaker. It was merely a vessel constructed strongly enough to withstand the tremendous pressures if it were unfortunate enough to become caught in the ice. In the middle twenties the *Bear* was replaced by the Coast Guard cutter *Northland*, but the *Northland*, although a steel hull, was not an icebreaker. At the same time, in terms of knowledge of operation in ice, insofar as the United States is concerned, I would say it was confined generally to those Coast Guard officers who had served on these vessels, plus some few people, explorers, who by reason of their

expeditions into the far North, could contribute some knowledge about ice conditions but very little about operating in ice.

Locally, the Coast Guard was occasionally called upon to break ice in harbors in the United States in the interest of commerce, but this was a duty that had grown slowly over the years following World War I, and did not, in effect, spell out a requirement for an icebreaker. The Coast Guard met this increasing problem of breaking local ice first by strengthening some existing vessels, or by altering their bow conformation, and in the instance of certain vessels constructed in the late twenties and in the early thirties, strengthening these vessels so that when called upon to break harbor or river ice the hulls would not be appreciably damaged. However, none of these alterations was ever conceived of in the sense of converting these vessels to icebreakers as we now use the term.

As a matter of fact, the responsibility of the Coast Guard for breaking ice even in the harbors of the continental United States was not defined as a duty until 1936 when an Executive order, No. 7521, provided in part:

> The Coast Guard * * * is hereby directed to assist in keeping open to navigation by means of icebreaking operations insofar as practicable and as the exigencies may require channels and harbors in accordance with the reasonable demands of commerce * * *.

Even this authority did not establish a requirement for the United States or the Coast Guard for a vessel specifically designed as an icebreaker, and it was the advent of World War II that led the thinking in the United States and the Coast Guard to the matter of acquiring icebreakers.

It occurred in this manner: Between 1939 and 1941, the committee will recall that there was considerable activity on the part of the United States to insure that Greenland did not fall into the hands of the Nazis. Here, again, it was the Coast Guard that was called upon to provide transportation back and forth to Greenland for certain Government representatives who, in effect, were the representatives of the United States to the Danish Government in exile and their territory of Greenland. Recognizing that the United States, if it stayed out of the war, would have to provide some sort of effective protection to Greenland, or if we were drawn into the war, as we subsequently were, would be operating in the area, the Coast Guard requested money for construction of icebreakers to operate in this general region.

I will not bore the committee by repeating any of the testimony that Admiral Waesche, then Commandant of the Coast Guard, gave before the Committee on Appropriations on the second deficiency appropriation bill for 1941, but suffice it to say this was the first attempt in the United States, insofar as I am able to ascertain, to obtain funds to build icebreakers. In preparation for building these vessels, an officer was sent to the Scandinavian countries to gather such information as could be obtained on the experience in that area in the construction of icebreakers. Money was appropriated for the construction of four icebreakers, which were designed by Gibbs & Cox, in collaboration, of course, with the Coast Guard. The United States, by now being a participant in the conflict, and the Coast Guard having been transferred to the Navy, these vessels were constructed at Western Pipe & Steel Co., San Pedro, Calif., under the joint auspices

of the Navy-Coast Guard although, in my opinion, it was still, and remained throughout, primarily a Coast Guard operation.

These four vessels were called the *Wind* ships because it was planned to name them, as they were launched, the *Northwind*, *Eastwind*, *Southwind*, and *Westwind*. However, before the first vessel was commissioned, the Soviet Government, then our ally, made a request for the transfer of these icebreakers to their custody. This request was acceded to in part. The *Northwind* was commissioned in 1943 by a Coast Guard crew, with some Russian key ratings aboard for training, sailed to Seattle and was turned over to the Russians. The second vessel, the *Eastwind*, was retained by the Coast Guard, and Rear Admiral Thomas, USCG (retired), who testified before you yesterday, was her first commanding officer. The *Southwind* and the *Westwind* were treated like their sister ship, the *Northwind*, and turned over to the Russians. At the same time, money was allocated for three replacement icebreakers. However, these three were not completed until after the war, so that at the end of the war the United States possessed one seagoing deep draft icebreaker, manned and operated by the Coast Guard. On transfer of the Coast Guard to the Treasury in 1946, this vessel remained a part of our fleet.

I should now like to divert for a moment from the seagoing picture to that of the Great Lakes. The committee will recall, of course, that one of the big problems throughout the war, and particularly the early stages thereof, was the matter of steel production. Early in the conflict steps were taken to increase this production by not only liberalizing certain loadline requirements for Great Lakes ore carriers, but also by prolonging the operational season of the carriers through freeing the channels used by the carriers of congested ice.

Actually, the only equipment on the lakes in the early 40's which was suitable for combating the ice that would collect in the various channels were the car ferries that operated across the Straits of Mackinaw back and forth from the lower to the upper peninsula of Michigan. In 1942, the Coast Guard entered into contracts to hire these vessels for certain periods to break ice, but their operations were somewhat restricted by the demands of their trade, and it was obvious to Admiral Waesche, as well as a very eminent member of this committee whom some of you will recall, that the solution to the problem would be a specially constructed icebreaker for the Great Lakes. The gentleman to whom I refer was, of course, the late Fred Bradley, of Rogers City, Mich., who for many years served ably in Congress, and was at one time chairman of this committee. As a result of his leadership, money was allocated for the construction of an icebreaker generally similar in size to the deep sea icebreakers, though minus the combatant armaments of the latter. That vessel, the *Mackinaw*, is operating today on the Great Lakes. The *Mackinaw*, of course, at the time of building and today, is restricted to use on the Great Lakes, but with the opening of the St. Lawrence seaway, could be withdrawn.

I should also mention that during the early period of the war, with requirements for keeping our harbors and channels open in the interest of the war effort, there were a number of other vessels constructed with varying degrees of icebreaking capabilities. For example, in 1942 the *Storis* was built for a particular use in subpolar regions, especially off Greenland and Labrador. In addition, 38 buoy tenders, primarily

for Great Lakes use and northeastern rivers and harbors, also had icebreaking capabilities incorporated in their design. Also for the Mississippi River, four ice plows were built for use with river tenders. But all of these fall far short of being called, in a strict sense, an icebreaker.

I have already indicated that when the three icebreakers were transferred to the Russians, the three additional keels were laid down, and these vessels were completed in 1946 and 1947. I am sure that when these keels were laid down it was contemplated that the Coast Guard would man these vessels when completed, and while I cannot document this, I think had the Coast Guard been in a position to man and operate these vessels when commissioned, there would have been no objection on the part of the Navy to our doing so. However, we were then in the throes of the very drastic cutback from wartime strength, and I recall being present at a conference in the then Commandant's office as to what position the Coast Guard should take with respect to these three new *Wind* class vessels. We were faced with the alternative of taking all of them and manning part of them, putting the others in mothballs; taking none of them and leaving it to the Navy as to what should be done with them; or finally, an intermediate position. Keeping in mind that we were at that time already operating one of the original vessels and the Navy none, and our then straitened position, both as to appropriations and personnel, the latter position was adopted. We took one of the vessels, which became the new *Northwind*, and although, as I have indicated, I have no record of this, I am sure that Admiral Farley suggested to the Navy that they take the other two, which became, on commissioning, the *Burton Island* and the *Edisto*.

This condition continued through the next several years—the Navy and the Coast Guard operating two seagoing icebreakers, with each service maintaining one on each coast. During this period the two services cooperated in such far northern work as was necessary, as well as the operation High Jump to the Antarctic. About this time, the committee will recall that there was considerable agitation for the United States Government to recapture from the Soviet Government the combat vessels transferred to them under the wartime condition, and in 1950 one of the vessels returned by the Soviet Government was the icebreaker *Southwind*. I do not recall that there was any particular discussion at that time as to which service would man the vessel, it being assumed, as I recall it, that in the then state of our appropriations we would be unable to do so. As a result, the Navy placed the vessel in commission and named it *Atka*. Late in 1951 the Soviet Government returned, among other vessels, the two remaining *Wind* ships, the old *Northwind* and *Westwind*, and on their return to the United States in the spring of 1952, the question arose as to the manning and operation of these vessels. Again, while I cannot document it, I believe that had the Coast Guard been prepared to undertake the manning and operation of both these vessels, we would have been permitted to do so. However, the Navy took the old *Northwind*, now the *Staten Island*, and we took the old *Westwind*, a name it still carries.

Since that time, as I am sure has been testified to before, the Navy has built one additional icebreaker, the *Glacier*. Also, the Canadians

have built an icebreaker, the *Labrador*. These two vessels are built essentially on the basic design of the *Wind* ships, though modified and improved. Thus, in summation, the United States today has 8 seagoing icebreakers and 1 Great Lakes icebreaker. Of the seagoing icebreakers, the Navy operates 5 and the Coast Guard 3, with the Coast Guard operating the Great Lakes icebreaker, for a total of 4 out of 9.

Coming specifically now to the bills before this committee, I think it is important to examine not only the statutory authority under which the Coast Guard engages in icebreaking, but likewise the justification for icebreaking by the Coast Guard. I mentioned earlier the Executive order of 1936, and that it remained the basic authority for the Coast Guard until this committee, in cooperation with the Judiciary Committee, recodified the Coast Guard laws in 1949, at which time the following language was specifically set out:

> The Coast Guard * * * shall develop, establish, maintain and operate, with due regard to the requirements of national defense, * * * icebreaking facilities * * * for promotion of safety on and over the high seas and waters subject to the jurisdiction of the United States * * * (14 U. S. C. 2).

In addition, title 14, United States Code, section 993, states:

> The commandant may maintain * * * icebreaking vessels * * *.

This, then, is the authority for our icebreakers, and in discharge of the duty set out thereby, establishes our justification within the measure of the requirements of the situation. It is the establishment of these requirements that is the difficult problem.

Before attempting to analyze these, it might be well to keep two other sections of title 14 of the code in mind. One is the military readiness function of the Coast Guard, also in title 14, United States Code, section 2, and I quote:

> The Coast Guard * * * shall maintain a state of readiness to function as a specialized service in the Navy in time of war.

The second provision that I have reference to is covered in chapter 7 of title 14, under the title "Cooperation with other agencies," but the specific language can be taken from section 141 (14 U. S. C.), wherein it says, and I quote:

> The Coast Guard may, when so requested by proper authority, utilize its personnel and facilities to assist any Federal agency * * * to perform any activity for which such personnel and facilities are especially qualified.

I have already indicated that the establishment of the requirements for another Coast Guard icebreaker as such can be difficult. You have before you a letter, already placed in the record, stating the administration's position with respect to H. R. 9196 and related bills. Insofar as the need for an additional icebreaker in the Coast Guard at the present time is concerned, I would be forced to say in all candor, if asked a specific question, that based on specific known and immediate requirements of the Service, and by that I mean the Coast Guard, I cannot document or justify an additional icebreaker. In fact, there is only one area that I can see even a probable demonstrable Coast Guard requirement. I will mention that in passing, yet with the acknowledgment that at this stage it can only be purely speculative. We know that for a number of years there has been considerable agitation on the Great Lakes for an additional icebreaker, particularly in the lower

lakes, and for several years a bill was introduced in Congress to provide such an icebreaker for the Buffalo area. It is my opinion that the requirement set forth in that bill was not sound. However, with the opening of the seaway, we in the United States are confronted with a changing situation. It may well be that with the opening of the seaway, if commerce develops to the extent that it is hoped, there may be a need to keep the lower areas, such as Lake Erie and Lake Ontario, open for longer periods than the normal ice-free operating season. If this develops, then the Coast Guard may be faced with the necessity of providing an additional icebreaker. This requirement could possibly be met by transferring one of our existing seagoing icebreakers into the lakes, and by replacing the gap left through such redeployment by a new seagoing icebreaker.

Leaving my statement just a moment, Mr. Chairman, I unfortunately could not be here Wednesday, because I was attending a meeting in Canada of the Dominion Marine Association and the Great Lakes Carriers, and I had to leave before the banquet at which the principal speaker was the Minister of Transport of Canada.

I received a call yesterday that I missed something that might be quite in point, and I mention it now because while I was speculating in this paragraph which I have just read, apparently the Canadians have also been speculating.

The item of interest in the speech by the Department of Transport Minister was the fact that he announced Canada is considering building a nuclear-powered icebreaker, and from the little bit I have been able to get from the newspaper reports of the Toronto paper, presumably, a plan is underway to use the icebreaker in the Arctic in the summer and in the lower St. Lawrence in the winter.

If the chairman would like, I will be very glad to put this newspaper article into the record.

The CHAIRMAN. We would be glad to have it in the record at this point.

(The article referred to follows:)

[From the Globe and Mail, Toronto, Canada, January 23, 1958]

TRANSPORT DEPARTMENT MOVE—CANADA CONSIDERING BUILDING NUCLEAR-POWERED ICEBREAKER

HEES PLANS TO SET UP COMMITTEE

By Arthur Brydon

Seigniory Club, Quebec, January 22 (Staff).—Canada is studying the possibility of building a nuclear-powered icebreaker, Transport Minister Hees said here tonight.

He was speaking to the annual joint meeting of the Dominion Marine Association and the United States Lake Carriers' Association.

A Transport Department committee will be set up to investigate nuclear propulsion with a view to applying nuclear power to Canadian icebreakers in the future, Mr. Hees said.

Russia launched an atomic icebreaker, named the *Lenin*, last year—first country in the world to harness nuclear power for icebreaking work.

The committee also will work with private Canadian companies interested in nuclear-powered ships or propulsion units for general commercial use.

Mr. Hees did not elaborate or say whether any Canadian shipping lines are now considering such projects.

Mr. Hees said that most of the new ships being built for the department will be provided with helicopter platforms. It is well established that helicopters have a major role in marine search and rescue, he said.

The minister said 4 ships now operating and 5 under construction are fitted with the platforms. Five more designed and issued for tender this month are similarly equipped. All the ships mentioned are icebreaker or buoy-tender size.

"As new ships become available, it will undoubtedly be desirable to expand our helicopter operations in connection with our ships," he said, "provided the necessary funds are voted for this purpose by Parliament."

The department's icebreaking fleet will have to be enlarged to meet growing needs for ice clearance work. Six icebreakers are now in service and two more are being built.

However, on the Upper Lakes, Canada has no icebreakers and depends on the United States for this service.

Mr. Hees said the St. Lawrence seaway will not be able to fulfill its purpose unless it is economically possible for a large volume of shipping to use it.

The minister outlined some of the safety facilities which will be available to ships using the seaway. He said the department will establish a coastal radio station at Cardinal which, with existing stations at Montreal, Kingston, and Toronto, will give fullest communication coverage to increased shipping in the seaway. He said both United States and Canadian governments are studying the problem of radio traffic control.

His views on the question of seaway tolls were in keeping with those of the two associations, he said. Canada's economy is very much dependent on cheap water transportation, he added.

His reference to tools was a brief one because they are being discussed by a joint United States-Canadian committee.

The DMA has maintained that no tolls should be charged on the seaway, claiming that any charge would have to be passed on to the producers and consumers, thus raising freight rates to a point where seaway users might be priced out of competition.

The text of a supplementary brief to Mr. Hees was released earlier this week. It proposed that a system for toll collections be set up and operated for a trial period without money being taken. It was claimed the data would prove the association's point.

Mr. Hees did not refer to a subject which many delegates had hoped he would broach—the report of the Royal Commission on Canada's coasting trade. This report, which the lake shippers hope will recommend legislative protection from foreign competition after the seaway opens, is understood to be in Government hands and release is expected soon.

At a press conference before his speech, Mr. Hees said that when he returns to Ottawa he will investigate reports circulated here that the seaway would not be completed by 1959. Some officials believe that while locks and canals will be finished the waterway will not be dredged to its full 27 feet.

Mr. Hees said he would also look into the matter of dangerous currents reported on the upriver side of the newly completed Iroquois lock.

Admiral RICHMOND. Aside from this possibility, the only other specific Coast Guard justification which I would add would be that of discharging our military-readiness function. Stating this another way, if we had additional icebreakers, then obviously more Coast Guard personnel are going to be trained and ready for operation under polar conditions in the event of another emergency. Further, since it would appear that the future source of power for combatant ships in the event of an emergency may well be atomic power, it would be highly desirable, from the standpoint of the Coast Guard, to have a cadre of personnel familiar with the operation under atomic propulsion.

You will note, however, that I say that it would be desirable, but I could not, as I indicated, in all fairness say that this is a present necessity.

Stating my position another way, with the exception of the *Mackinaw*, the three *Wind* class icebreakers operated by the Coast Guard are not primarily in support of the basic icebreaking responsibility of the Coast Guard insofar as local waters are concerned. Therefore, their use, or the use of other large icebreakers, by the Coast

Guard must be largely justified on the grounds of cooperation with other agencies or in support of our military-readiness function, and generally a part of the overall contribution by the Coast Guard to the national defense effort.

This, then, brings me to the position that, since we are presently operating our seagoing icebreakers primarily in the interest of an overall national requirement rather than a specific duty of the Coast Guard, H. R. 9196 and its companion bills must be justified on the basic national requirement. Stating that another way, if the present eight seagoing icebreakers are inadequate to meet our national requirements for national defense, search and rescue, and commerce generally, then the requirement for additional United States icebreakers is established. Assuming such a requirement, I think it could be generally agreed that the source of power for propulsion of the icebreaker, in the interest of expanding our field of experience and knowledge, might well be atomic. Further, the possibility of the vessel having to spend long periods in polar regions, particularly if caught in the ice, always a potential and real hazard, makes the long sea-keeping ability of nuclear power a very desirable advantage. Thus, if these two points are established, it is my opinion and position that the Coast Guard should man this new project. I make this statement on the grounds that we are not novices at the operation of icebreakers, and in fact believe we can say that insofar as the United States is concerned, lead the way in this field. I am confident that in any operation of an icebreaker as is envisaged by H. R. 9196 and H. R. 9978, the personnel of the Coast Guard is as well qualified, competent, and able to operate the vessel as efficiently as any other agency.

Just as we are not novices in the matter of icebreakers, neither are our technical people novices in the matter of atomic power. While we presently operate no reactors, as this committee knows, we are cooperating with the Atomic Energy Commission and the Maritime Commission in the development of plans for the operation of the *Savannah*. In the final analysis, it will be necessary for the Coast Guard, under our merchant-marine authority, to regulate those people who must operate the *Savannah*. Therefore, our technical people have been keeping abreast of developments in the field of atomic propulsion in order that we can adequately discharge this function. Further, we enjoy a very close relationship with the Navy Bureau of Ships, and I would anticipate no problems at all in the area of interchange of information in this field.

In short, I would sum up my testimony by stating that if, in the interest of the United States, an additional icebreaker is to be built, atomic or otherwise, the Coast Guard should be the agency designated to operate it.

Mr. Chairman, that concludes my prepared statement.

Several years ago the Disney Studios—Walt Disney—undertook to make a movie of the operations in the Arctic. They spent 2 seasons, most of the time on our ships, the *Eastwind* and the *Westwind*, and took some 80,000 feet of film which was reduced to a short picture which takes about 31 minutes, which went on to become an academy award winner; in fact, the last academy award that Disney received. It also received a very high award at the Berlin film festival.

We are very proud of our part in this picture, and we are prepared to show it to the committee if the committee would like to see it. Some of the members have seen parts of it at one time or another before the picture was completed, because I showed some parts of it before and, perhaps, some of you have seen it at the local theaters when it was being distributed. However, I think it is worth while seeing it again, if the committee wants to take the time.

We can either show it now, or after my questioning, sir.

The CHAIRMAN. Well, the House is not in session today, and I think most of the members of the committee would enjoy seeing the picture in its fullness.

Admiral RICHMOND. Would you like to have it now, sir?

The CHAIRMAN. Yes, sir.

Admiral RICHMOND. I might say the only criticism—and you might be interested in this—that I ever heard of the picture was a person who said that he felt the ending was a little too, shall we say, "storybook," because as you will see when we come to it, one vessel was caught in the ice but, actually, that was really what happened. It is not a storybook ending to a story. It is thoroughly documentary.

(Thereupon, the movie entitled "Men Against the Arctic," was shown.)

The CHAIRMAN. That was a very interesting picture, Admiral and gentlemen.

Admiral RICHMOND. Thank you, sir.

The CHAIRMAN. Have you finished with your statement, Admiral?

Admiral RICHMOND. Yes, sir.

The CHAIRMAN. Mr. Thompson, did you desire to ask some questions at this point?

Mr. THOMPSON. Just one question, Admiral Richmond:

If the Coast Guard did secure an atomic-powered icebreaker, what advantages would you have in breaking ice, for instance, over any other way?

I understand that the breakers now carry enough fuel for a season. Therefore, it really is not a matter of having more distance capacity or more fuel-carrying capacity, because you do carry enough fuel for the entire season now.

Would you obtain more power, or just what would you get out of the training of a cadre on a nuclear-propelled vessel?

Admiral RICHMOND. I would say essentially it would be the endurance factor, sir, particularly in our future Antarctic operations. That has all been gone into before the committee, and another factor would be that undoubtedly any icebreaker—although this does not follow entirely from the nuclear side of it—will have to be larger in all probability with the present development of reactors and that increased size, in itself, is an advantage both from the cargo standpoint and the matter of living accommodations or accommodations for research and that sort of thing.

Mr. THOMPSON. Do you think the advantages of a nuclear-powered icebreaker would offset the extreme costs as we know them today?

Admiral RICHMOND. Well, my feeling on that, sir, is that if it were a question purely of, you might say, the relative cost of the two perfected powers, there might be something in that, but my feeling in this matter of nuclear power, as I indicated in my statement, is that we are

only—I say "we in the Coast Guard," but I am speaking generally—are only on the threshold of it, and I think that is a factor that cannot be set off in dollars and cents, sir.

Mr. THOMPSON. That is very true, but the Coast Guard really is not the agency for trying out experimental models except, of course, in the range of your own duties, and it would seem to me it might be well for one agency to keep developing this nuclear power so it will be a package which will be more practical for use.

Admiral RICHMOND. Well, sir, my answer to that would be that right now it is not confined, shall we say, to one agency, sir.

Mr. THOMPSON. Neither are missiles, but we have seen some disadvantages in that.

Admiral RICHMOND. Well, I will not debate that one with you, sir.

What I mean when I say "more than one agency," if you figure in terms of developing reactors, we have right now for different uses a divergence of effort such as, for instance, the *Savannah*.

Mr. THOMPSON. I understand, and believe me, Admiral, anything that we can do for the Coast Guard to render it more effective we want to do it.

Admiral RICHMOND. I am sure of that, Mr. Thompson.

Mr. THOMPSON. You have been dong a grand job as spread out as you are. However, I know of many areas where you could well stand to have more money in your budget, and could do a more effective job, but I am wondering if you had in mind penalizing other activities by spending some of your money on developing this nuclear-powered icebreaker?

Admiral RICHMOND. Well, now, you have posed a different question, sir. I understood that I was not testifying on this bill on the question of "either or," sir. If you look at my statement, my position, sir, is that if in the national interest another icebreaker is to be built, and if that should be nucelar-powered, and if in the wisdom of Congress in the passage of the bill it should be built, I feel that the Coast Guard is the proper agency to do it, and we are as capable as any other agency to do it, sir.

Mr. THOMPSON. Right. I asked the question in that way only to point out if it were coming out of your budget, would you think that there were more areas more expedient at the present time?

Admiral RICHMOND. I can answer that very quickly, sir.

If it were coming out of my budget, I would not do it.

The CHAIRMAN. I have deferred that part of our interview, if you term it that way, with the Coast Guard, because I realize what you are leading up to. The Coast Guard is in dire need of rebuilding. Here we are dealing with a subject that if we do not advance it, somebody else will be away ahead of us. As the admiral has stated, there without a doubt will be development of nuclear power in the ice breaker field by others because we have sat back and let other nations develop nuclear energy and already a nuclear-powered icebreaker has been built.

Whether it is for scientific purposes or whether it is an advantage to commerce in the future is a question that has been well studied here. The necessity of it, according to the record, I think is well established.

The admiral is testifying as to who will operate it. I think it has been shown by past history the Coast Guard is more advanced in this field than any other agency of Government.

Mr. THOMPSON. I agree. Power is power. If you can get cheaper power, we want it with a longer period of operation, without refueling.

The CHAIRMAN. For your information, I would like to have read to you what the Russians themselves say about this subject.

Mr. THOMPSON. I agree. I am not saying we should not have one but I would like to develop facts by studying the Coast Guard budget with relation to what the decision would be if they had to pay for it.

The CHAIRMAN. This would be a supplement.

Mr. THOMPSON. We have a larger budget, a national budget. It stands to reason if the admiral had to take money out of his budget and stop other operations, perhaps more vital to him, look at the overall picture. If we take it out of some other area we have to stop some other activity in favor of this. In the development of power it would seem to me you could develop it on submarines or cargo vessels that travel vast distances.

I think there is a matter of public relations with the rest of the world. Russia is in a program of that sort. After this power is developed and found to be economical and the size of the package can be reduced to at least cargo carrier capacity, you could readily install one in an icebreaker and accomplish the same purpose. The training of a cadre could be accomplished to operate such a vessel. I wonder if this would not put the Coast Guard in competition with some other agency in developing power. It was testified here that the present icebreakers carry enough fuel for the entire season at present.

The CHAIRMAN. It has also been testified that 3 months in the year is insufficient to ascertain the scientific facts and gather the data that we must gather if we are going to keep abreast of the world today and learn why things are caused here and why things are caused there.

Mr. THOMPSON. What type of scientific documents?

The CHAIRMAN. It has been developed in the record if you read that.

Mr. THOMPSON. I have listened to part of it and most of the scientific data are developed from stationary stations and not from the icebreaker.

The CHAIRMAN. I had better read the record over to you. You go ahead with your discussion.

Mr. THOMPSON. My question is whether or not the icebreaker would be timely, nuclear-powered icebreaker, in view of the great expense involved, whether you could not develop nuclear power that could be adapted to any icebreaker at any time considered feasible.

The CHAIRMAN. Your icebreaker has to go in and come out and it is impossible to maintain a year's existence for scientific purposes.

Admiral RICHMOND. That is right. This episode at the close of the picture, as you remember the text, they indicated plans were going on. We were actually set to evacuate the greater portion of the crew, leaving the vessel only to all intents and purposes an icebound hulk with a residue crew aboard for caretakers simply because she does

not carry adequate supplies to last her through the winter for a full crew complement.

Mr. THOMPSON. How would nuclear power have changed that?

Admiral RICHMOND. As I indicated, a larger ship, no larger crew, you have more capacity and also the fuel requirements. It was testified here yesterday as an example, and has been testified to by others that particularly in these Antarctic operations, even their summer operations have been restricted because of the limitations on fuel. In moving in they have to take either a calculated risk on getting out or may not be able to take the chance because of the fuel limitations on all existing icebreakers, the length of period they can in effect be operated.

Mr. THOMPSON. I had understood Admiral Will to testify that icebreakers normally carry a full season's supply of fuel. That was in answer to a question by Mr. Allen.

Admiral RICHMOND. Again, when you talk about icebreakers there is a tendency to classify them all in one group. The capabilities of an icebreaker we will say for one job may have to be considerably different from one operating in the Antarctic. Speaking now from the national standpoint I think any icebreaker that is constructed must be a compromise of all those factors. There is no doubt that certainly for Antarctic operation, if we accept that as a continuing and future job, that the present icebreakers, whether Coast Guard or Navy, definitely have limitations for even summer operations.

Mr. THOMPSON. Under the present concept for nuclear power for such vessels, how much saving in cargo space, considering the fuel, would there be?

Admiral RICHMOND. That I cannot answer. I would rather defer to the technical people on that particular point.

May I say at the outset that with respect to any future icebreaker or even consideration of the icebreaker that might be built if this bill became law, that thinking generally in terms of type, specifications, and that sort of thing must be very, very general because, as I say, all of these things I have mentioned—namely, compromise of requirement, where you are going to use it, et cetera—have not been carried through to an ultimate answer.

Therefore, to date any thinking in this field I think is pretty general. I might say that at the present time our thinking is it would probably be an icebreaker in the neighborhood of 350-foot length, equal to at least the beam of the present icebreakers if not more, preferably more, and on that basis perhaps Admiral Cowart could give us some idea of the additional capacity.

Admiral COWART. The present wind ships have a cargo capacity of about 326 tons. That is cargo. I believe the *Glacier* has about 500 tons capacity. Preliminary thinking on a vessel of the type the commandant has mentioned, we would be thinking in the range of 500 tons. But that is only preliminary thinking at this point.

Mr. THOMPSON. You would not gain too much cargo space.

Admiral COWART. The figures I have indicated are something in the nature of 300 to 500. The design could change that considerably. What would be desirable in the characteristics of the vessel—there would be many factors to be settled. That would be one of them.

Mr. THOMPSON. Do you have size limitations on what size icebreakers you could use flexibly? Could you use say a 500-foot ship as effectively as a 300?

Admiral COWART. You are thinking of length or beam?

Mr. THOMPSON. Length or beam. Is there not a limitation? You could not get an ocean liner, regardless of how tough the skin was, through some of the ice that a much smaller boat would more effectively break up.

Admiral COWART. We note that the Russian breaker is 440 feet in length. Our wind ships are about 269. The *Glacier* is 310.

Mr. THOMPSON. Which are the more effective in breaking ice?

Admiral COWART. As to how effective the Russian breaker is, we can only imagine that it is more effective, we would feel it is.

Mr. THOMPSON. You feel a much larger ship than the winds would be more effective in reaching this point?

Admiral COWART. With larger beam ships, commercial ships, becoming more common, it is desirable that the beam of the breaker be as large as the largest ship you expect to escort into the ice-bound areas.

Mr. THOMPSON. Your power requirements are much greater?

Admiral COWART. The larger the ship, the larger the power requirements.

Mr. THOMPSON. If a development of this kind would result in anything of value to us in our development of nuclear power, I am for it. I am trying to develop whether or not the same power could not be developed and perfected in some other possibly cheaper way than going into a nuclear-power icebreaker while we have nuclear-powered submarines with changes made every year, a nuclear-powered cargo ship which could run for indefinite periods and development being made on the powerpack all the time.

The CHAIRMAN. Let me repeat what Mr. Siple, who has been with the Byrd expedition, continuously said in his testimony:

> Sixty percent of all cargo in explorations had to be fuel at a relative cost of $10 per gallon.

Mr. THOMPSON. I have not asked the question yet as to how much space would be saved by nuclear propulsion. Would there be a saving there?

The CHAIRMAN. I do not know the answer.

Mr. THOMPSON. I think the question should be answered.

The CHAIRMAN. This is in the record:

> Up to 30 percent of the displacement of an ordinary icebreaker is accounted for by fuel of which it must carry thousands of tons. An icebreaker of the Soviet Arctic fleet, for example, carries 3,000 tons of fuel and daily expenditures exceeds 100 tons. This prevents icebreakers from staying far from port for an extended period.

Mr. THOMPSON. That answers one question but not the other.

The CHAIRMAN. You mean how much difference in cargo?

Mr. THOMPSON. Yes, and cost.

The CHAIRMAN. I think he went further and said with these figures before you it might be more economical under atomic energy.

Mr. THOMPSON. I would say in the future no doubt all our vessels and perhaps also planes could travel more economically and greater distances. My thought is in development whether this would be in

competition with somebody doing the same job which would be developing a powerpack per se to be used in any vessel.

The CHAIRMAN. Do you gentlemen have any observation on why the Russians are doing this?

Admiral RICHMOND. It would only be speculation, sir. As I indicated to Mr. Thompson, I think one of the dangers of this situation and why it makes Mr. Thompson's question so hard to answer is that in addition to establishing the need you have to establish what specific need. From the little bit I know of the Russian setup, their needs are somewhat different from ours. Their coast is different, their icebreaking problems are different. Just as our problems, if we are considering the Arctic versus the Antarctic must be somewhat different.

Mr. Thompson asked a question as to this relative size. From the testimony I have heard here yesterday and from what I believe was said earlier, I would put it this way. If your primary mission was to operate in the Antarctic, it would appear to me that size, greater length from what Admiral Thomas said particularly with respect to running straight leads, not having to have curved leads or hairbenders, as he said, that length and size one is a decided advantage.

I can think of other cases, sir, where if your primary need was relief in the Arctic, where size could be a disadvantage to you, particularly in some of the areas where we are required to support the DEW line operations in shoal water. If you go in size you get greater draft and immediately you limit your operations. We all know these supertankers are specific-purpose ships.

I will try to return to the Russians. I think they have a very definite purpose. They need large cargo capacity, and presumably from other things read into the record from Russian articles they need large, passenger-carrying capacity. I think someone used the figure of a thousand. I cannot conceive that they will ever carry a thousand crew and scientists. I can only believe they are going to move a thousand people. If that figure is accurate, they must be considering their icebreakers as a passenger-carrying facility in addition to these other functions.

In a sense that answers your question, I think, because they presumably felt that along with the advantages they might get out of atomic power, that that is the only way in a 440-foot vessel they could get this extra capacity.

Mr. THOMPSON. Is it not true you have the fort of Vladisvostok and others where great amounts of cargo are moved?

Admiral RICHMOND. I think so. As a matter of fact, from what I know of their operation, their operation is entirely different from ours. In 1942, when these ships were being built, I hoped to have command of the first one. I was stationed in Alaska. I happened to have the job of escorting the *Stalin* into Seattle, and hoping that I would get command of the first vessel, I prevailed upon the shipyard—we were both in the same shipyard for overhaul—to get me aboard the icebreaker and talk to the skipper.

I will have to admit I doubt if I got a very good story from him because they were a little reluctant, even in wartime, to have me come aboard. I also had to talk through an interpreter. But essentially as he told me the story then, I have no reason to feel that it changed materially, and I think it has been borne out by other things, the Russians at that time, and I believe still, use their icebreakers along their

northern coast and the northeast passage like this. Unlike our northern coast, the Canadian northern coast where you have a lot of islands and passes, theirs is practically an open coast with promontories. The ice collects on the promontories and they station their icebreakers on those points to act as escort vessels for 200 or 300 miles east of that point until the cargo vessel gets 200 or 300 miles west of that point, at which time they get into the indentations and run in open water to the next promontory.

I could see in their case, answering your question specifically on atomic power, they would have a need to keep a vessel there for maybe several years and where fueling would be a considerable problem.

The CHAIRMAN. Let me call Admiral Thomas up to testify with respect to the question raised. Will you come forward?

You know Admiral Thomas' background?

Mr. THOMPSON. Yes.

The CHAIRMAN. Put your question to him.

Mr. THOMPSON. My question was whether or not the development of this nuclear-powered icebreaker would be to any great advantage to us, considering the cost involved and whether or not we would have additional cargo space that would be useful to us by savings in weight and space of the new propulsion unit.

Admiral THOMAS. In my opinion, sir, yes. Do you wish me to elaborate?

Mr. THOMPSON. Yes; I would like to learn something on it.

Admiral THOMAS. As I testified yesterday, from the standpoint of endurance I think we are going to have to support Antarctica for some time to come. We do not always have a guaranty that there will be an abundance of fuel in the Southern Hemisphere. As I mentioned in my discussion, the political situation can change very rapidly and perhaps deny us oil entirely. In that case it would be necessary for us to have atomic-powered, one atomic-powered vessel, in order to properly support our activity.

As far as the Arctic is concerned, I think it has already been brought out by Admiral Richmond and others that there is a desirability for a vessel to winter over in the pack. It has also been brought out that the present type of icebreaker or an icebreaker which uses fossil fuels would not have the capacity to sustain herself throughout the winter and still get out in the following spring or following summer.

As far as the dimensions of the icebreaker, I mentioned yesterday, sir, that I was informed after a length of 350 feet, I think, or some similar figure, the personnel requirements level off. In other words, you can have an icebreaker such as the Russians and still have no increment in the personnel requirements over a 350–foot icebreaker. The same of course goes for fuel.

It is desirable in my estimation to have a larger icebreaker because you are able to do a much better job on breaking a channel for a convoy. One of the factors or integrals in the successful operation with ships in convoy is length. You have to be able, as Admiral Richmond mentioned, to steer a straight track. If you do not, that means the entire column has to be broken out from rear to van and set in motion again. Often times that can be a dangerous operation because the stern ship has to be in motion before the icebreaker breaks out the vessel ahead of it. So unless the job is done abruptly and with

plenty of power available, it might result in damage to the vessel and perhaps vitiate at least in part the purpose of the expedition.

Also of course to support beam you have to have length. As Admiral Richmond indicated just now, your larger ships are getting beamier and beamier. You have to have a sufficient beam in your icebreaker to compensate for that of your escorted vessel.

I know, according to reports, that the Russian icebreaker, the *Lenin*, has a beam of 90 feet. I mentioned yesterday I felt that any ship we build should match those dimensions in order to provide efficient convoy and to provide endurance and a considerable scientific platform as well as for other logistic use.

Mr. THOMPSON. You feel that the Russian icebreaker is much more efficient than anything we have?

Admiral THOMAS. Yes, sir.

Mr. THOMPSON. Because of its size in addition to the power?

Admiral THOMAS. Yes, sir.

Mr. THOMPSON. You feel that putting a nuclear pack into an icebreaker at this time would result in our keeping that particular pack over a long period, or do you think the nuclear power has been developed to the extent that say it will be in 5 years?

Admiral THOMAS. By pack you mean——

Mr. THOMPSON. The power unit. In other words, do you think we will be going into experimentation with Coast Guard icebreakers that will be far more expensive for changeovers at the same time we are doing it for submarines and cargo vessels?

Admiral THOMAS. I think the reactor—I am not an expert—I think it has been developed and proven in operation in at least the *Nautilus* and you have to have some sort of experiment. The *Nautilus* in a way was an experiment as a prototype. You have to have a prototype icebreaker to use it as a basis for a class unless there is urgency for immediate construction of many ships of that class.

Mr. THOMPSON. I was thinking of whether or not we were getting in competition with other agencies in development of a more efficient power unit. Power is power, regardless of whether it is in an icebreaker or cargo vessel. As far as the power unit is concerned, if we are developing one it seems we could as well concentrate on developing that one to where we thought it was efficient enough and then use it in whatever types of ships we need in various sizes of course.

Admiral THOMAS. I think there is a division of the Atomic Energy Commission which is concerned with the development of marine installations. As Admiral Richmond said, there has been already a diversity in effort among the Navy and the merchant marine. I do not think, Mr. Thompson, that it would be a question of competition in this case.

Mr. THOMPSON. Of course I have been very sensitive to the criticisms on development of missiles because a missile is a missile, regardless of how it is used. I would favor one agency developing it and allocating use of it to whatever service had the need for it. I want to be sure we do not get into the same situation that many men of good will and many good scientists have gotten themselves into so far as the American people are concerned and spending the tax dollar is concerned.

Admiral THOMAS. As Admiral Richmond said, I will not debate that with you, sir. My personal opinion is you have to base your construction upon the requirement.

Mr. THOMPSON. You feel there is a nuclear power pack unit, now, that is efficient enough to serve the purpose economically in the case of an icebreaker?

Admiral THOMAS. In my opinion, yes, sir.

Mr. THOMPSON. Thank you. That is all, Mr. Chairman.

The CHAIRMAN. Thank you, Admiral.

Mr. THOMPSON. Thank you, Admiral.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. I have 1 or 2 questions. I did not hear the first part of your statement.

Admiral RICHMOND. It was basically historical as far as the first part was concerned. I was merely pointing out therein that this is, you might say, pioneering, whether it be in Alaska or where, not new to the Coast Guard or our predecessor, the Revenue Cutter Service.

Mr. TOLLEFSON. I was leading to this: That you say in your statement that an atomic-powered icebreaker is not justified at this time because there is no present need for it.

Admiral RICHMOND. I did not quite say that. I said I could not document, as far as the Coast Guard statutory duties, the need for an atomic icebreaker—statutory duty of breaking ice you might say locally. That my position was however, while not evaluating the national requirement either in the Arctic or Antarctic, that if it was decided that another icebreaker should be built, atomic or otherwise, that I felt the Coast Guard because of our earlier experience in bringing the modern icebreaker to the United States, was as qualified as any other agency.

Mr. TOLLEFSON. The concern came to me as I listened to your testimony that the Coast Guard was not thinking in terms of future needs. I hope that is not so.

Admiral RICHMOND. We are thinking in terms of future needs, sir, but actually as I indicated in my statement our present seagoing icebreakers are primarily—I said this in my statement—in support of national effort rather than you might say the specific statutory requirements of the Coast Guard, even the ones we are operating today. That national interest is something that we in the Coast Guard may have our opinions on but we are not the ones in the final analysis who can evaluate it, sir.

Mr. TOLLEFSON. Would it be a fair question to ask you whether you think it would be in the national interest to have an atomic icebreaker?

Admiral RICHMOND. In view of the testimony that I heard here yesterday and accepting the premise undoubtedly that we are going to be in the Antarctic, I would say "Yes."

Mr. TOLLEFSON. In your statement you say that so far as the United States is concerned, the Coast Guard leads the way in the icebreaker field.

Admiral RICHMOND. Has led the way, I will put it that way.

Mr. TOLLEFSON. I agree with you. My question is: Could you likewise say that you lead the way in the world?

Admiral RICHMOND. No, I do not think so, because as I indicated, very frankly, the Scandinavian countries and the Russians had a requirement and built icebreakers 30 or 40 years ago. Before the war, as I indicated, if you had gone up to somebody and said, What do you think about an icebreaker, they would have said, What do you mean? They would have thought of something to crack ice cubes. It is a term that developed in this country based fundamentally on a wartime need or prewar, in that interim period before we entered the conflict.

Mr. TOLLEFSON. If we should decide to stay in Antarctica at the end of the IGY, there would probably be need for an icebreaker or icebreakers in that area; would there not?

Admiral RICHMOND. I would say very definitely. I do not think there is any question about that.

Mr. TOLLEFSON. If among other requirements of the installation we might have in Antarctica there would be need for fossil fuels, they would have to be brought some distance; would they not?

Admiral RICHMOND. Yes, sir.

Mr. TOLLEFSON. That would be particularly true if we got into an emergency and could not rely on a source of supply from a nation closer to the Antarctic than ours?

Admiral RICHMOND. That is correct.

Mr. TOLLEFSON. In the event that situation arose, atomic-powered icebreakers would be a very important item.

Admiral RICHMOND. It would be very important for two reasons. I gather from your statement you are assuming we are in an emergent condition, that bases are there of some nature in the Antarctic.

First I believe I am right in this—Admiral Thomas has been there and can back me up—our present source of fuel for both the bases and the vessels we send down there, whether Navy or Coast Guard or anything else, is New Zealand. If we assume that New Zealand is removed as a source of fossil fuel for either the bases or for the vessels going down, we have no way of resupplying that base unless we have a facility—I say "we," I am not talking about the Coast Guard, I mean the United States—have a facility capable of proceeding to those bases without the use of fossil fuel and also taking whatever fuel is necessary to them. As Admiral Hirshfield pointed out, if you want to evacuate your bases and get your personnel out, you would have no means of reaching them in the hypothetical situation you have set up.

The CHAIRMAN. During World War II, did the Coast Guard have considerable experience in the Arctic? If they did, for what purpose? These are the same icebreakers, present icebreakers, that were available then?

Admiral RICHMOND. Yes. As I indicated in my statement, the 4 were built for the war effort to be manned and operated by the Coast Guard but only 1 of them got in commission during the war and that was the *Eastwind*. The other three were turned over to the Soviets practically upon completion. We manned them with our own officers and crew but with Russian ratings for training, took them to Seattle and turned the three over to the Soviet Government. The other one, the *Eastwind*, came out under the command of now Admiral Thomas and operated mainly on the east coast of Greenland, is that correct?

Admiral THOMAS. Yes; that is correct.

Admiral RICHMOND. As far as combatant activities I think your main participation was in the capture of the, what was the name of the German vessel that was trying to put a radio group ashore?

Admiral THOMAS. *Externestiene.*

The CHAIRMAN. For what purpose was Germany in the Arctic area?

Admiral RICHMOND. They were attempting to set up a station on the Greenland coast. I think since Admiral Thomas was a participant, he would be better able to describe accurately what took place.

The CHAIRMAN. Was there a deficiency in our icebreaking ability to go into that area where Germany was established in World War II?

Admiral RICHMOND. As I have indicated in my statement, there was a general deficiency of any ability to break other than local or harbor ice with made-over equipment when we entered the war. By the time we got in the war, plans had been laid down and we were starting to build ships. But the *Eastwind* went in commission when?

Admiral THOMAS. June 3, 1944.

Admiral RICHMOND. We had no icebreakers until 1944.

The CHAIRMAN. Let me pose this question. If Germany was in this Arctic region in World War II, they were in there for some purpose.

Admiral THOMAS. Yes, sir.

The CHAIRMAN. That purpose, does it exist today in that degree or greater degree? If the situation were to develop again what would take place in that area?

Admiral THOMAS. I think the same situation would develop, Mr. Chairman. The Germans were in there for the purpose of weather information. Knowing that weather moves from west to east, the weather information from Greenland was of vital importance to them in their activity against the Murmansk route along the coast of Norway. They were desperate to get this weather information.

Also the region was very good from the standpoint of communications and they could relay directives to their submarines at a considerable range which otherwise they would not have been able to do. For that reason they used every effort to establish themselves on the north coast of Greenland, northeast coast.

The CHAIRMAN. Was it a mission of the Coast Guard to destroy those weather stations?

Admiral RICHMOND. Yes, sir, particularly keeping in mind that the thought on this started before we were in the war. As a matter of fact, I also indicated in my statement, you will recall, that of course early in the war Germany took over Denmark. However, the American Ambassador became the representative here of the Danish Government in exile. On the international situation that left a neat problem. We were not in the war but we recognized a potential danger. There was one other aspect as I recall it that was very, very important to us at the time, and that was that there are a number of deposits of cryolite in Greenland, and there was considerable concern as to the possibility that Germany, having overrun Denmark, would exercise control over Greenland and take over these cryolite mines which were our only source at the time.

Admiral THOMAS. That is right.

Admiral RICHMOND. Using the Coast Guard because very frankly although we are military we were even then in the Treasury Department and it would not be as obvious as dispatching naval vessels to

do the job, the first vessel to go up was the 165-foot vessel, *Comanche*, which carried the consul up. The State Department sent up a consul. We made several trips during that period, carrying people back and forth. Also I indicated in my statement that led to the next question which was: How are we going to maintain this posture of in effect recognizing the Danish Government in exile and protecting their island of Greenland? That in turn led to the consideration of: How do you operate there? An officer was sent to Scandinavia to find out what knowledge could be found out about icebreakers. You will find all of the testimony, a lot of the testimony, set forth, some might have been off the record, in the 1941 supplemental hearings when Admiral Waesche appeared before the Appropriations Committees asking for the money to build the original icebreakers.

The CHAIRMAN. Are there any further questions?

Mr. ALLEN. Admiral Richmond, if it were the desire of the Congress to build one of these icebreakers with this new concept of having included laboratories and accommodations for a variety of scientists and to have such a vessel undertake explorations as well as go in for traditional duties of a Coast Guard vessel, would it be necessary or desirable to pass some legislation which would include these missions as a mission of the Coast Guard?

Admiral RICHMOND. I do not think it would be necessary. I would like right now to say that—I referred in my statement to our authority to cooperate with other agencies—I would also like to say that obviously any vessel that would be built under this or any other legislation would not be constructed without due consideration of the military readiness function and in close cooperation with the Navy and undoubtedly other agencies to work into the vessel every facility that would make it in the national effort the most able vessel that it could be.

Whether we like it or not, that would undoubtedly lead to certain compromises in design. Just as, for example, from a straight icebreaking standpoint the *Mackinac* on the Lakes is probably just as able a vessel as any of the seagoing vessels, but if it were to be used during the war on the ocean it would have to be converted to a combatant vessel. It has no armament.

Also keeping in mind that the original *Wind* ships were designed primarily as combatant icebreakers, postwar experience has brought to all of us, Navy, Coast Guard, and the other agencies—that an icebreaker might well be something more than just a combatant vessel.

For example, when the *Eastwind* was damaged a number of years ago, recognizing the desirability of carrying more cargo because we had an entirely different problem to meet, we took out the forward engineroom for the bow propeller and converted that to cargo space. Of all the Coast Guard's icebreakers the *Eastwind* is not true to type today. It has more cargo capacity.

Mr. ALLEN. Whose responsibility would it be to determine what fields of activity such a vessel should go into?

Admiral RICHMOND. Actually if you are thinking in terms of specific statutory authority for anyone, I do not think it exists anyplace.

Mr. ALLEN. Does that not add up to saying if we want something as a matter of national policy determined by Congress, it would take legislation? If we want to authorize a ship, it would be a matter

of the executive branch getting together in a cooperative way and determining what the executive branch wanted to put in?

Admiral RICHMOND. If you wanted to document it, yes, but if you go on the basis of experience in the past, what has been done both in this area and others, I do not think that would be a requirement. I think the experience of the work of the Coast Guard in cooperating with other agencies, both scientifically and otherwise, there would be no problem. I wonder whether you need it. It would not hurt.

For example, we cooperate with the Weather Bureau and the Coast and Geodetic Survey in their surveying work. There has never been any great question raised about the desirability of it or you might say any statutory limitation. Nobody has come along and said, "Well, you cannot do this."

Mr. ALLEN. I was a little concerned not with the past, because I think it has been commendable, but whether or not there was a desire to change the policy and go into a field that was not traditional. In that case it seems it might help to have a legislative pronouncement.

Admiral RICHMOND. I would use the present experience in the International Geophysical Year. I hope you will not ask the question, but if you ask me by what authority we spent the money to send the *Northwind* to the Antarctic on either Operation High Jump or any subsequent one, I would have to find some vague authority in the fact that we did it for training, the training of Admiral Thomas and the crew in military readiness. As far as specific authority, if the GAO asked questions, I would be in a tough spot, sir.

Mr. ALLEN. It would be a little hard for them to undo the work.

Admiral RICHMOND. They would have a hard time getting the money back, I agree, sir.

Mr. ALLEN. The Navy indicates that the Dew line operation and the supply of those stations is going to be turned over to a commercial operation. Admiral Will told us that in planning the MSTS operation they had the assurance ahead of time of icebreaker service before they went in from both Navy and Coast Guard.

Would a commercial operation have the same assurance planned ahead of time or would it go in and get in trouble and then call for help?

Admiral RICHMOND. Sir, you are in a field that, for me, is rather troublesome. Speaking quite frankly, the situation is this: When the MSTS went into that project, which is basically an Air Force project—there is a lot of talk about friction between agencies, but this is cooperative—Air Force is basically putting up the money and employing MSTS to do the job.

As part of our cooperation in the job, we are putting in certain icebreakers within the limits of what we felt to be our capability to do the job, namely, the *Northwind* and the *Storis*.

The first year, when they got into trouble up there, if you recall, you probably heard Admiral Denebrink describe the ice conditions not following true to form, the Navy, MSTS, came to us and said: "What can you do about helping us out?" We diverted four tenders which should have been out handling buoys, et cetera, from the Alaskan and west-coast areas; certain moneys were paid by MSTS to make minor conversions; they were rushed in, and the job was a success. Not necessarily MSTS, Air Force, or Coast Guard, but it was a United States success. No lives were lost. It was handled in that manner.

At that time, we said, "We cannot continue each year to give you this additional support. Maybe next year you will not need it, but we cannot." Nevertheless, feeling there was a possibility, they said, "Can you make available, in subsequent years, certain tenders?" We said, "We can, providing you will help us financially." So, an arrangement was worked out, and since that time we have been working on that basis.

Now we move to the situation; the stations have been constructed and there is considerable talk that MSTS will get out of the business and that they will turn the whole job of the United States support minus that of the McKenzie Basin, which is being handled through the Canadians, over to commercial contractors.

At that point there is a tendency to get a bit loose in the language and say, "Now, since we have made a contract with a commercial company to do this job, it becomes a commercial enterprise, and, therefore, the Coast Guard, per se, should be on the spot to protect them."

That is fine, in theory, but the point is we cannot be on the spot every place to protect everybody. My feeling right now is that we will give no commitments to any commercial company; that we will not provide them with an icebreaker to assure that they are going to get through, for the simple reason that to do so, for them to take a defense contract, we would be subsidizing their operation.

I may be wrong, and I may have to back down from that position. What I think would actually happen is this. If it is decided to make it commercial, undoubtedly some contractor, I do not know who, will come to us and we will say "No." At that point, if he can get insurance, he will enter a bid and take the job. Maybe he may get away with it a year or so and someday the ice will catch him up there and popular opinion will rise up and say, "These poor people are freezing to death on the Arctic coast." The Coast Guard has to go to the rescue and we will have to spend a lot of money to make an effort to pull them out. That is my prophecy and opinion only.

Mr. ALLEN. As of the moment, do you have the equipment to do that as regularly as the contingency is likely to occur?

Admiral RICHMOND. It is possible, but, on the other hand, in our cooperation with the Navy we have other commitments to the Far North, aside from the DEW line.

Mr. ALLEN. Putting my question a little differently, do you now have a field of activity, in intensity at least, that is in addition to the fields of activity you had 10 years ago?

Admiral RICHMOND. That is correct. But how we will deploy our vessels, or what we will support them for, still remains a moot question as far as that operation up there. As a matter of fact, I do not worry about it too much, because we are not faced with the immediate proposition. We are doing it now in support of MSTS. What may be done about letting it to private contractors, I do not know.

Mr. ALLEN. One more question on that line. Will you be attempting to take care of the additional responsibilities with the same equipment you had before the responsibility arose?

Admiral RICHMOND. I would say we would have to look at the conditions under which these people are going to operate very carefully to see whether or not we can properly use our equipment in support of this particular contract.

Mr. ALLEN. Under the present situation, the merchant-marine operation has no right as a matter of law to command whatever service they get from you, a service you would extend to them, in a sense, voluntarily and within——

Admiral RICHMOND. We have a duty to extend it but, again, within the limits of our equipment we have to balance the requirements. Even in the United States we have the same requirements. About this time of year, about every 2 weeks we get indignant cries because we have not opened such-and-such a channel, possibly in New England, for an oil carrier or something to get through. We are giving that service but, again, it is within the limits of our facilities and we have to balance the equipment we have against the requirements.

Mr. ALLEN. One other question on the construction of icebreakers and their characteristics. Are they built appreciably strong to withstand the crushing of the ice, or are they built so they will squeeze up out of the ice and be relieved of the pressure, or, if the ice gets the wrong way, does it just crush the icebreaker?

Admiral RICHMOND. I will defer to technical people. I would say it is something of both, although, with the present steel-hulled icebreaker, I do not think it is anticipated that it will do much squeezing up out of the ice if it really gets in pressure. Would you say that is true? It does have a very smooth hull structure and, you might say, almost saucer shaped, which would help in that, but I think, with the weights we are dealing in, I think what you have in mind is the theory of some of the old whalers that if caught in ice, rather than being squeezed, they might well rise up and rise on top of the ice to some degree.

Admiral THOMAS. To answer the question, I was informed by Captain Simonson, who had a great deal to do with the hull design that the *Wind* class would, in theory, rise when in a squeze. I was never in such a situation myself, so I do not know whether or not they actually would. But a ship will rise, as Admiral Richmond indicated. When we captured the *Externestiene*, she had risen high in the ice because she had been built for that sort of squeeze.

Mr. ALLEN. Thank you.

Admiral RICHMOND. I might say when that picture was going there were two things. One answered your question. You saw the *Westwind* frozen in the ice. She was not sitting on top of the ice.

The other thing is, you remember, yesterday you were asking Admiral Thomas a question about these lakes that might be encountered in the polar ice, and in that picture as they flew over the pole, there were, as you may have noted at the time, some open lakes there apparent in the icepack.

The CHAIRMAN. From your testimony, one would come to the opinion that MSTS is going to have to continue to supply the DEW line themselves.

Admiral RICHMOND. That would be my feeling for several years, anyway.

The CHAIRMAN. Unless there is some assurance that open navigation will be available and the protection available, private industry is not going to send their vessels in to supply the DEW line, are they?

Admiral RICHMOND. The question has not been put specifically, sir, but I think if the question came up as to what we would give them,

we would be in the rather untenable position of letting private industry submit a bid based on, you might say, a convoyed vessel which I do not feel at the present time our broad statutory authority gives us the right to promise.

Mr. DREWRY. Admiral, do you feel that under section 141 (a), if MSTS, having responsibility, or the Department of Defense, having responsibility to see that those stations are supplied, were to request assistance from you, that you would not be able to provide that assistance?

Admiral RICHMOND. I did not make that statement. We are doing that right now with MSTS. My point is if MSTS gets out of the business and the Government comes to you and says, How much will you take to supply our stations—you are operating a commercial company, you have to make your bid on that job on the basis of getting your ships in and out without coming to the Coast Guard and saying, Look, if I make this bid, can I depend on you to send two icebreakers along with me to make sure I do not lose my vessels.

The difference is we are in support of commerce but is this truly commerce in the sense of moving commerce, as we understand the term? This is actually a defense project.

Mr. DREWRY. That is my point. Commercial vessels under contract with the Department of Defense carry the goods in there but obviously they have to have a way to get in. There are no known icebreaking facilities in private hands. Nobody is being contracted with to do that in support of a Government project. It seems to me your law is perfectly clear that in support of that the DEW line is a military project, they farm out the supplying of it by cargo ship to commercial operators under contract, but they continue to have to depend on you or the Navy to break the way for them to get in and out.

Admiral RICHMOND. I will put it this way, sir. It all depends on how the question is asked. If the question is put to us at the time in support of the defense effort or in support of the Defense Department, will you provide icebreaking facilities, that will be one thing. But, if they simply say nothing about that and simply contract, we will not promise the contractor that he can depend on us because of the commercial aspect of his venture to go in there and support. Our support will be on the defense aspect and the cooperation with other agencies, not on the commercial provisions.

The CHAIRMAN. Your support would have to be at the request of Defense?

Admiral RICHMOND. That is essentially my position.

The CHAIRMAN. Industry would not contract unless they were so assured.

Admiral RICHMOND. I am doubtful. When it comes to the showdown of actually contracting they will want a guarantee.

Mr. ALLEN. Admiral, suppose they do contract with a private operator to supply those stations and suppose the operator gets stuck on the way up. How would the stations get supplied?

Admiral RICHMOND. That of course would have the answer as I referred to before. We will probably repeat the history of 1900 or the history of 1955 and all-out efforts will be made to rush supplies in because in the final analysis it will be going to the rescue and assistance of our own citizens.

Mr. ALLEN. I was thinking that in addition to that we seem to consider this DEW line as a very necessary part of our Defense Establishment, and if it is so, could it run for a year if help came sufficiently late or in sufficiently small quantities that a convoy did not get in there?

Admiral RICHMOND. I cannot answer that specifically because, very frankly, there are a number of stations and I would say it would vary with different stations. You saw in this picture a case where no matter what we did, we could not reach it with the heavy lift material. That station existed through that winter although it happens to be a major station, without a ship ever getting there.

Undoubtedly food and many things could be dropped to a lot of stations and actually even now they are being supplied in part through the winter by air. So it would be impossible to give you a direct answer. My guess is that certain stations you might have to evacuate the crews and others might be able to continue on through the winter.

Mr. ALLEN. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Mailliard?

Mr. MAILLIARD. Would it not be fuel that would drive them out?

Admiral RICHMOND. That would be my guess.

Mr. MAILLIARD. You could supply them with everything else but it would be hard to supply fuel by air.

Admiral RICHMOND. That is right.

Mr. MAILLIARD. I want to see if I get your general position on the legislation correctly. It seems to me what you said is that if the Defense Department or national defense policy indicates that there is a military requirement in some possible future war for this type of icebreaker with these particular capabilities and in addition to that if they decide that the scientific data which might be collected by this type of ship which cannot be collected by any type of ship we now have, then it is your contention you could operate it for them?

Admiral RICHMOND. I would add one other thing. I would not limit it necessarily to only the military and the scientific because I think there is another responsibility of the Coast Guard which ties in very definitely. If we accept the premise, Mr. Tollefson's assumption, that we will have bases in Antarctica, I think we have a further national interest in what we call search, rescue, and assistance.

It is not a question of arriving at a national policy alone on scientific knowledge or military requirements, but our overall national interest.

Mr. MAILLIARD. I was trying to see what areas——

Admiral RICHMOND. Essentially that is correct. We have eight icebreakers now. If that is not enough to do the potential job and we need 9, 10, 11, or 12 icebreakers and 1 or any of them is going to be atomic powered, my position is the Coast Guard is as able as any other agency and has as much knowledge in the field as any other agency in the operation of those icebreakers.

Mr. MAILLIARD. Forgetting the operation for the moment, assuming we grant your position is correct on that, what about the design and construction of the ship? Should that also be placed primarily in your hands?

Admiral RICHMOND. Let us not kid ourselves. The design of a reactor will be primarily, I believe—certainly it will be under AEC

and definitely in cooperation with the Navy setup. No, I do not believe in any of this development it has been exclusively in one hand other than possibly the *Nautilus* development—Admiral Mumma can speak more on that—even there the Navy undoubtedly collaborated very closely with AEC. If you think in terms of our having the ball and running with it exclusively——

Mr. MAILLIARD. I think the statutes provide clearly that the AEC has the responsibility on the reactor. But it seems to me in all our conversation here it has developed that if this ship is worth building at obviously substantial cost it has to be a multipurpose vessel.

Admiral RICHMOND. That is right, sir.

Mr. MAILLIARD. The question that comes to my mind in reading the bill is this. This bill authorizes to be appropriated to the Treasury Department, United States Coast Guard, and Atomic Energy Commission such sums as may be necessary.

Have we perhaps left out the agency of Government which will have the most at stake in the design of the vessel—I am not talking about the propulsion—but its accommodations for the various scientific personnel, its particular military requirements in some possible future conflict if we have to operate in the Arctic or Antarctic, how do we get this design? Should the responsibility for expending the funds be Treasury and AEC or should Defense definitely be in this picture.

Admiral RICHMOND. Defense will defintiely be in, whether you specify it or not, because we do not build anything without consultation with the Defense Department, looking toward our military readiness function and the fact that we operate as part of the Navy in the event of an emergency.

Mr. MAILLIARD. We could be assured if we passed the bill in its present language that such agencies as have been represented in some of the testimony here that are interested in the scientific areas—I think particularly of the Office of Naval Research, et cetera—that they would all have full opportunity to state their requirements.

Admiral RICHMOND. Yes, sir; definitely.

I mean, even if we forget all icebreakers, and if we were building a cutter, we always would refer to the Navy, I presume, or at least we would talk with them and we have to for this reason: For example, all our armaments are subject to the Navy's review. We would go to the Navy if we want for any reason to change the armament on our vessel. We will not change an armament right now, or change a gun without prior concurrence of the Navy. Certainly, it would not hurt to spell it out but, actually, as a matter of a practical situation, whoever builds this thing, it is going to be a cooperative effort.

Mr. MAILLIARD. Is there any statutory requirement now under a general law which says if the Coast Guard is going to build a ship, it has to consult with the Bureau of Ships, or are you legally a free agency?

Admiral RICHMOND. I would say legally we are a free agency. There is no statutory authority that says we have to go to the Bureau of Ships and get permission to do certain things.

Mr. MAILLIARD. Could you, for instance, according to law, go out and buy your own guns if you wanted them?

Admiral RICHMOND. Yes; I think we could. Of course, it is not a practical suggestion, sir, because very frankly the only people that have them are the Navy.

Mr. MAILLIARD. I think you see what I am getting at. I want to get this in the record as much as anything else; what I think is quite clear, regardless of what the bill might say, that the testimony on this bill has indicated that this is a multipurpose vessel with a rather wide variety of uses, and if it is built, it is probably going to be the only one that will be built for quite a while, and I simply want the record to show that all these other agencies would have a very vital interest in it.

Admiral RICHMOND. I might go one step further and say that on this vessel any armament put aboard presently is paid for by the Navy on our vessels now, and much of our equipment and materiel such as radar is supplied by the Navy right now out of Navy funds.

That does not apply to radar, but it applies to all armament and all our CIC equipment, and all our ASW equipment, which is supplied by the Navy.

I would like to dispel one idea here that might have gotten around that this is sort of a competitive idea. Reference was made to missiles and that sort of thing. I do not think this is the same type thing. In the first place, any icebreaker that is built—and we have mentioned the *Wind* ships, and they were modern design, yes—but fundamentally they were not basically changed—and I am talking about the icebreaking idea—from those that have been constructed by other nations and I doubt if this is going to be a revolutionary ship in the sense that it will look different, or particularly different, from any other icebreaker. What we are really talking about here is a new and novel source of power, and the ship will be built to meet the requirements at the time that it is laid down—the requirements to carry the propulsion power and whatever that may be, and any additional improvements necessary for the then duty as it appears to those people who design it.

Mr. MAILLIARD. Admiral, I have no concern about the Coast Guard being able to determine with the advice and consultation of the Navy what the hull shape should be for the purpose of icebreaking, and I am sure the Atomic Energy Commission and the Navy and the Coast Guard can figure out a propulsion plant. However, I have been impressed with the testimony of these several days as to how many people and how many rather small bureaus and agencies might have quite a stake in the keeping of this vessel in the Arctic and the Antarctic, and it is a rather unusual ship, and I just was anxious to have the record show that.

There were no implications at all in my questions.

The CHAIRMAN. Admiral, in the testimony of the scientists and experienced people in the areas of the Arctic and Antarctic, and the drive of all nations for further exploration to obtain knowledge, in your opinion somebody or some agency of the Government is going to build an atomic icebreaker; would you think?

Admiral RICHMOND. I anticipate it; yes. And I may say I think the article which I put into the record this morning indicates that we are not alone in this. We have already heard what the Russians have done in this field, and we have just heard the other night that

the Canadians say they are thinking of building an atomic icebreaker. Therefore, it seems to me, thinking generally and looking at it in terms of the desirability of this type of propulsion for this particular type of craft——

The CHAIRMAN. So, if it is going to be built, I am convinced that it is going to be done shortly; and I ask you should it be your agency or some other agency to operate this ship?

Admiral RICHMOND. Well, I have already made the statement, sir, that I think we can do it as well as any other agency. I do not mean exclusively, because no agency can do it exclusively, sir.

The CHAIRMAN. But this is your field in season and out of season?

Admiral RICHMOND. This is our field. If I can draw upon a little amusing instance—at least, it was amusing to me—I might say that even the Soviets gave us a plug one time. We had a report that the Soviets had put out quite an article or, rather, quite a movie extolling the advances of the Soviet Government in the area of icebreaking. This movie was shown in Switzerland but, unfortunately, I presume the photographer, or whoever he was, is probably up in Siberia someplace now. They showed a picture of these fine, new Soviet icebreakers, but when they showed the picture of the bridge they happened to show the engineroom telegraph, and on it it said "United States Coast Guard."

So, I think that some alert observer wrote in to us and said he was surprised to hear that we were operating in the Soviet Navy.

The CHAIRMAN. Mr. Pelly.

Mr. PELLY. Thank you, Mr. Chairman.

I would like to ask Admiral Richmond if he would agree with me that, as the world, so to speak, gets smaller, the mission of the Coast Guard gets larger?

Admiral RICHMOND. Well, sir, my answer to that is that I think one of the biggest problems—maybe not the biggest—but let us say one that we spent a lot of time on is the name "Coast Guard," because during the war and since the war it has become very, very much a misnomer. We presently have activities which spread from Korea—although small—to the west, to Greece, Rhodes in the Mediterranean, and in the East we may be even farther spread in the not-too-distant future. We even have a couple of men in Liberia training the Liberian Navy. It consists of only two 40-footers, but at the present time that is the Liberian Navy.

Mr. PELLY. Well, has not the advent of air transportation on top of the surface transportation added greatly to your functions and spread out your scope of activity?

Admiral RICHMOND. Definitely.

Mr. PELLY. And in cooperating with such other agencies in their need for weather information and similar needed scientific data, you have to stretch yourself thinner all the time?

Admiral RICHMOND. Yes, sir.

Mr. PELLY. As one of the authors of this legislation, I have had in mind that one can be too modest in anticipating the amount of equipment that you need to properly fulfill the function, although I realize that that may be due to something beyond your own control.

Admiral RICHMOND. Thank you for those words, sir.

Mr. PELLY. Have we not now a four-thousand-odd-mile additional coastline on the north which you are called upon to perform important functions such as icebreaking?

Admiral RICHMOND. That is correct, sir.

Mr. PELLY. And is not the shortest air route to western Europe now right over the pole, and will not the frequency of air travel over that short route increase your problems of helping support bases in the north, weather supply stations and other bases in the north?

Admiral RICHMOND. It could very well. I could not give you a specific answer because, first, to my knowledge, there are no routes particularly over that area.

Mr. PELLY. You mean air routes?

Admiral RICHMOND. Air routes. I mean definite air routes. Of course, there is this confusing element: Much of any route, of course, would pass over Canada where you might say the responsibility for service such as that performed by the United States and other nations, will be performed by the Canadians.

I think this committee knows that the Department of Transport of Canada considers themselves—and in many ways are—the parallel organization to the Coast Guard, although in many of the duties there are very definite differences.

However, last week—I do not have it with me—on the floor of Parliament a member of the opposition party rose to challenge the Minister of Transport—the same gentleman I referred to earlier—and asked "Why does not Canada have a Coast Guard?" His answer was that the United States Coast Guard does this, and we do that, and therefore, we do not need a Coast Guard, but they feel that their organization is parallel to ours.

Incidentally, along that line, as you may know, the *Labrador* is no longer operated by the Canadian Navy. It was originally built for the Canadian Navy but it is now being operated by the Department of Transport.

Mr. PELLY. Aside from the military aspects and the importance of the polar cap it seems to me that our Civil Aeronautics Board has recently established definite air routes for American Airlines to Western Europe over the pole.

Admiral RICHMOND. Maybe I used the wrong word when I said "establish." I have not any doubt that you are quite right. What I mean is that I do not think there are any planes operating on a definite schedule over the pole. Perhaps I am wrong.

Mr. PELLY. On the contrary, I think you will find they are, and will increase greatly. The Scandinavian Airline goes to the Pacific coast by the polar route. However, I think it is obvious that if you project your thinking into the future the short manner of getting to Western Europe and, indeed, to the Soviet Union, is going to increase in importance and that we should anticipate that the Coast Guard might well have additional functions.

Admiral RICHMOND. It could very well be.

Mr. PELLY. As far as the military functions go, is it not true that there have been definite statements that a pack of nuclear submarines—had we any such number of them—could hide under water and come out into open water and could discharge missiles at a potential enemy, and as such I would think it would be of great interest to the military

to have the Coast Guard equipped with adequate icebreaking facilities so that we could supply bases up there and provide weather information and, indeed, chart the seas in the Arctic?

Admiral RICHMOND. Yes, sir.

Mr. PELLY. I say again I think you have been althogether too modest in stating the needs of the Coast Guard, certainly as far as the future goes, because it seems to me every time there is an air disaster, why, the Coast Guard is called into service, and more and more as the world gets smaller, you seem to have more duties and responsibilities.

If I may say so, I do think, considering the equipment and manpower and duties that you have, you do a most astoundingly excellent job, which makes it the duty of Congress to add to your equipment so that you can even do better, and which equipment you will need to have in the very near future.

Admiral RICHMOND. Thank you, sir.

The CHAIRMAN. Are there any further questions, gentlemen?

Mr. GROSS. Mr. Chairman, I am sorry that I had to leave for another committee meeting, and I hesitate to ask questions because they may have already been asked, and answered, but as you well know, Admiral, our immediate interest in waterborne commerce in the midwest is the Great Lakes, and the navigable streams such as the Mississippi and to some extent the Missouri.

On page 9 of your statement you say that with the opening of the St. Lawrence seaway, the one icebreaker on the Great Lakes could be withdrawn.

Just what do you mean by that statement?

Admiral RICHMOND. I merely meant that that is a possibility. At the present time we could not get it out.

Mr. GROSS. You did not mean that it would be withdrawn?

Admiral RICHMOND. No, sir; in fact, sir, I would hope that no one gets that idea because I will be besieged by indignant representatives of the Great Lakes region if they get that idea. I merely meant it would be practicable.

Mr. GROSS. I thought that is what you meant. Mr. Chairman, I would like to ask one other question: In what condition did the Russians turn our icebreakers back to us?

Admiral RICHMOND. Well, sir, as I said we only took one of them over. The first one—the *Southwind*—was not in very good condition. The Navy would have to answer that specifically.

The *Westwind*, which was the one we took over, was not in too bad condition. They had kept it up very well. Of course, their standards are different from ours.

Do you have anything else on that, Admiral Cowart?

Admiral COWART. Well, they came back under their own power, and they were operable. The hull and the ship generally was in poor condition. They needed a lot of money spent on them to bring them back into good shape but, fundamentally, the machinery had been taken care of rather well.

There were no outstanding serious deficiencies.

Mr. GROSS. Did they pay us anything for the use of those icebreakers?

Admiral COWART. I do not know, sir.

Admiral RICHMOND. No, sir; I am quite sure I am right when I say "no."

Mr. GROSS. In other words, we picked up the bill both ways?

Admiral RICHMOND. Well, the war was on, and we made a present, sir. I think it was a time when we thought we were fortunate to recapture our ships.

Mr. GROSS. Just one other question, Mr. Chairman:

Is there any type of an icebreaker used on the Mississippi River?

Admiral RICHMOND. No, sir. What we had on the Mississippi were four iceplows. Actually, they were removable bows that they would put on them, and of course our tenders out there were all river-type vessels with square bows and this, in effect, was a "V." These were detachable plows that were on the tenders, but the problem there, as it later developed, was that the tenders themselves did not have sufficient power to properly handle the plows, actually.

Mr. GROSS. With the completion of the St. Lawrence seaway, would there be any possible benefit to opening the Mississippi to earlier navigation through the use of some sort of equipment for that purpose?

Admiral RICHMOND. Well, sir, the upper Mississippi we have from time to time engaged in icebreaking, mainly in the interest of commerce. As you recall in about 1948 or 1949 there was a very serious fuel shortage in Chicago, and some of the northern cities, before the necessary pipelines were built, and they got caught. I think it was in the winter of 1948. They had a very bad winter, and the dealers had not stocked adequately for this emergency. We had to let private contracts to some of the big tugs out there to break out primarily the Illinois River Waterway, and that continued up to about 2 years ago, breaking out the Illinois River Waterway practically every year.

You see, the great trouble with commercial breaking—not commercial, but private or local breaking—is the trouble of demand which is created by the emergency. We open in the interest of commerce to some extent, but primarily for humanitarian reasons.

Well, of course, you carry fuel or supplies in, but you open a channel and then all the tugs that have been tied up get out, and go on gainful pursuits.

So, immediately, you have created in the minds of anyone who has seen the convenience of this a good idea. After all, "why should we be locked in by the winter in the future?"

I can go back right here locally to the 1920's, and I am sure Mr. Bonner may remember that there was quite an emergency down on Tangier Island. They were without medical supplies, and so the Coast Guard came in and broke a channel into Tangier Island and brought in medical supplies and foods and so forth.

I have forgotten the exact year, but it was one of the very, very severe years in the area.

Well, of course, when we broke the channel open, then all the oyster fishermen got out into the bay and after that we were besieged with a complaint requesting us every year to come in and break the channel so they could go on their merry way. That is one of the problems, and that same condition pretty much built up in the Illinois River waterway after a while. The first year it was a necessity, but later they obtained a pipeline and the fuel problem was not the same. However, it was cheaper in the minds of the operators to keep the

Illinois River free than it was for the people who have the supply tanks to build new tanks so they would have an adequate supply to meet the emergency.

Mr. GROSS. Thank you, Admiral.

Thank you, Mr. Chairman.

Mr. DREWRY. Admiral, I shall be very brief.

You did not mention the date when you sent an officer to Europe, did you?

Admiral RICHMOND. Well, frankly, I am not quite sure myself, as a matter of fact.

The CHAIRMAN. Supply that for the record.

Admiral RICHMOND. Well, actually, I might clear the record, too. That is not absolutely a true statement. I found out after I wrote the thing that the officer happened to be in Copenhagen on leave, and this came up and he was sent a dispatch to proceed on up to the Scandanavian countries and make an inspection and report back. When I mentioned to this officer just the other day that I had said this, he said, "Well, you were wrong, because as a matter of fact the only travel I got out of it was the 10 days that I spent in the Scandanavian countries."

Therefore, technically, we did not send anyone to Europe. We happened to have him there on leave, and put him on duty for 10 days to make this inspection.

Mr. DREWRY. I want to pin down, if possible to do so, the date at which we made that survey.

Admiral RICHMOND. I think it was in 1940.

Mr. DREWRY. I thought I heard somewhere that it was about 1935.

Admiral RICHMOND. I think it was 1940.

Mr. DREWRY. In the case of a lake ship, and an ordinary one, we run those ships up to a period of 40 years, and the ship is still in good condition.

Admiral RICHMOND. That is correct.

Mr. DREWRY. In the case of some tankers, depending upon the service and the type fuel to be carried, they can become deteriorated—not merely obsolete—but deteriorated in less than 20 years. These ships that you have in the Coast Guard now—the icebreakers of the *Wind* class, are about 14 years old, are they not?

Admiral RICHMOND. That is correct.

Mr. DREWRY. In another 6 years they would be 20 years old. Do not you have, just as the merchant marine does, the problem of replacement?

Admiral RICHMOND. We very definitely do, sir. We set for normal service life a factor of about 30 years for all vessels. That will vary a great deal with vessels, and with regard to the icebreakers—I will probably get a lot of technical disagreement with this—the figure used in our forward planning is 35 years.

Mr. DREWRY. Thirty-five years despite the hard work that it has to do?

Admiral RICHMOND. Yes, sir; that is correct.

Mr. DREWRY. So, then, according to your estimate, the 20-year life means nothing as far as this type vessel is concerned?

Admiral RICHMOND. That is correct. I think that these vessels are basically good for the purpose designed, subject only to the wear

and tear. We have kept them up and I think they have a good many years of operational value ahead of them.

Mr. DREWRY. I mean aside from the question of obsolescence.

Admiral RICHMOND. Oh, yes; you always get into that question, but then you get into the question of the duties for which they are uesd.

As a combat ship, they quickly become obsolete, or you might add equipment which changes their stability enough, so that is a wide-open question, but speaking of the life of the ship, we feel they are good for 35 years. One thing we did encounter with the *Eastwind* was a bad accident—I say "bad accident"—but we stove a hole in her with a relatively small impact.

Again, Admiral Thomas was on board, but fundamentally I think the conclusion was that the fracture had resulted from that area crystallizing through the many impacts of service, but I do not think that shortens the life of the vessel. It simply means we have to be alert, you might say, to this form of crystallization that may result in the hull's destruction.

Mr. DREWRY. I would now like to direct one question to Admiral Cowart:

Admiral, you spoke of the condition of the hull of the icebreaker which was returned to us by Russia. What was the nature of that, and was its condition caused because they did not keep it painted?

Admiral COWART. It was more the case of a matter of not keeping the vessel up. The normal upkeep was very obviously not followed by the Russians. We would not have considered operating a vessel the way she was returned to us.

Mr. DREWRY. Just one more thing, Admiral Richmond:

With reference to the question of military readiness, that is a continuing proposition; is it not? You do not decide yourself in the Coast Guard all alone what your military readiness should consist of?

Admiral COWART. Oh, definitely not. Our war plans as such contain certain missions which have been assigned by the Navy. Of course, we have the broad authority, and we feel that it is one of our duties, although it is very hard to state in specific terms, but you might say a very primary duty, to keep the service, its personnel and its equipment to the extent practicable in a posture to go under Navy operations without anything more than the word to transfer.

Mr. DREWRY. I was thinking about Mr. Mailliard's line of questioning with reference to your existing basic authority.

Is not the basic authority that helps you develop your war plans in itself the thing which will make anything you do in regard to your equipment conform to wartime requirements as determined within the Department of Defense?

Admiral RICHMOND. Right.

Mr. DREWRY. That is all, Mr. Chairman.

The CHAIRMAN. Are there any further questions?

(No response.)

Thank you very much, Admiral.

Admiral RICHMOND. Thank you, Mr. Chairman.

(The following was furnished for insertion by the Commandant.)

BACKGROUND CONCERNING COAST GUARD ICEBREAKING ACTIVITY

The Coast Guard has always complied with its inherent responsibilities to aid vessels in distress by affording assistance to icebound vessels consistent with the capabilities of Coast Guard cutters. In 1936 added emphasis was placed on icebreaking operations in response to the President's Executive Order No. 7521 dated December 21, 1936, which read in part: "The Coast Guard, operating under the direction of the Secretary of the Treasury, is hereby directed to assist in keeping open to navigation by means of icebreaking operations, insofar as practical and as the exigencies may require, channels and harbors in accordance with the reasonable demands of commerce; and to use for that purpose such vessels subject to its control and jurisdiction or which may be made available to it under paragraph 2 hereof as are necessary and are reasonably suitable for such operations." Subsequent to this Executive order the maintaining of icebreaking facilities was made a statutory primary duty of the Coast Guard.

The following tables present the list of Coast Guard vessels that were designed or altered for icebreaking work and the areas in which they were employed as icebreakers:

Vessels no longer in commission

Vessel	Length	Year built or altered for icebreaking	Area of icebreaking activity
	Feet		
Bear	198	1878	Sub-Arctic, primarily Alaska.
Northland	216	1927	Replaced *Bear*, sub-Arctic.
Ossipee	165	1915	Northeastern United States rivers and harbors.
Kickapoo	151	1926	
Escanaba Class	165	1931-35	Great Lakes, Northeastern United States rivers and harbors, sub-Arctic duties during World War II.

The following vessels are in operation (January 1958) and have been used in icebreaking operations in the areas indicated

Vessel	Length	Year built or altered for icebreaking	Area of icebreaking activity
	Feet		
Raritan class	110	1939-43	Great Lakes, Northeastern United States rivers and harbors.
Ice plows for river (tenders 4)	59	1942-43	Mississipni River system.
Cactus class (38 vessels)[1]	180	1942-44	Sub-Arctic, Great Lakes, Northeastern United States rivers and harbors.
64-foot tugs (15 vessels)	64	1942-44	Great Lakes, Northeastern United States rivers and harbors.
Storis	230	1942	Sub-Arctic.
Wind class (3 vessels)	269	1944-45	Polar and sub-Polar, Hudson River.
Mackinaw	290	1944	Great Lakes.

[1] Six of these are ice sheathed for Arctic operations.

Attention is invited to the following classes of ships listed in the enclosure:

(*a*) Ten lightships are between 49 and 54 years old. Normal service life of these ships is considered to be 40 years.

(*b*) All of the 83-foot patrol boats are between 14 and 17 years old. Normal service life of wooden hulled patrol boats is considered to be 12 years. At present many of these patrol boat hulls have deteriorated to a point wherein the vessels are unseaworthy and must be limited to duty in confined waters or placed out of service entirely.

(*c*) All of the 125-foot patrol craft are between 30 and 31 years old. Normal service life of steel hulled patrol craft is considered to be 20 years.

(*d*) All of the 165-foot patrol craft are between 24 and 27 years old. Normal service life of steel hulled patrol craft is considered to be 20 years.

(*e*) All of the 63-foot and 65-foot harbor tugs are between 20 and 21 years old, and all of the 64-foot harbor tugs are between 14 and 16 years old. Normal service life for wooden hulled harbor tugs is considered to be 15 years.

(*f*) Two of the buoy tenders of the under 150-foot class are 37 years old. Normal service life of these vessels is considered to be 30 years.

ABBREVIATIONS

LOA: Length overall
DR: Draft
DISP: Limiting displacement
HULL: Hull material
E: Electrical system
PROP: Type of propulsion
SCR: Number of screws
SHP: Shaft horsepower
SP: Maximum sustained speed
ACQ: Acquisition
BLT: Year built

VESSEL DATA

Vessel data is common to all vessels of each class except where deviations therefrom are noted.

CODES

Hull Material:
- S: Steel
- W: Wood
- I: Iron

Electrical System:
- A: 440-volt 3-phase 60-cycle alternating current
- B: 120/240-volt 3-phase 60-cycle alternating current
- C: 120/240-volt single phase 60-cycle alternating current
- D: 120/208-volt 3-phase 60-cycle alternating current
- E: 115-volt 3-phase 60-cycle alternating current
- F: 115-volt single phase 60-cycle alternating current
- G: 125-volt direct current
- H: 120-volt alternating current/direct current
- I: 120-volt direct current
- J: 115-volt direct current
- K: 110/220-volt direct current
- L: 110-volt direct current
- M: 32-volt direct current
- N: 240-volt direct current

Propulsion:
- DD: Diesel direct
- DE: Diesel electric
- DER: Diesel electric reduction
- DR: Diesel reduction gear
- GAS: Gasoline
- TE: Tubine electric
- TR: Turbine reduction
- REC: Reciprocating
- RU: Reciprocating, uniflow

Acquisition:
- 1: Vessels built under a Coast Guard contract or project order
- 2: Transferred from Navy
- 3: On loan from Navy
- 4: Transferred from Army
- 5: Transferred from former Light House Service
- 6: Transferred from WSA
- 7: Gift

Vessel list

GUNBOAT, 327-FOOT CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WPG	31	Bibb	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1937	Boston, Mass.
	32	Campbell	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1936	St. George, Staten Island, N. Y.
	33	Duane	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1936	Boston, Mass.
	35	Ingham	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1936	Norfolk, Va.
	36	Spencer	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1936	St. George, Staten Island, N. Y.
	37	Taney	327	41	15	2,827	S	A	TR	2	6,200	19.0	1	1936	Alameda, Calif.
		SEAPLANE TENDER, SMALL													
WAVP	374	Absecon	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	Norfolk, Va.
	381	Barataria	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1943	Portland, Maine.
	382	Bering Strait	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1944	Honolulu, T. H.
	370	Casco	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1941	Boston, Mass.
	383	Castle Rock	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1944	Do.
	375	Chincoteague	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	Norfolk, Va.
	384	Cook Inlet	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1944	Portland, Maine.
	376	Coos Bay	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	Do.
	385	Dexter [1]	311	41	14	2,800	S	A	DR	2	5,800	17.5	2	1941	Coast Guard Yard, Curtis Bay, Md.
	387	Gresham	311	41	14	2,800	S	A	DR	2	5,800	17.5	2	1943	Alameda, Calif.
	378	Half Moon	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	St. George, Staten Island, N. Y.
	372	Humboldt	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1941	Boston, Mass.
	371	Mackinac	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1941	St. George, Staten Island, N. Y.
	373	Matagorda	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1941	Honolulu, T. H.
	386	McCulloch	311	41	14	2,800	S	A	DR	2	5,800	17.5	2	1943	Boston, Mass.
	377	Rockaway	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	St. George, Staten Island, N. Y.
	379	Unimak	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	Cape May, N. J.
	380	Yakutat	311	41	14	2,800	S	A	DR	2	5,800	17.5	3	1942	New Bedford, Mass.

GUNBOAT, 255-FOOT CLASS

WPG	68	Androscoggin	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Miami, Fla.
	41	Chautauqua	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	Honolulu, T. H.
	64	Escanaba	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	New Bedford, Mass.
	43	Iroquois [1]	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Coast Guard Yard, Curtis Bay, Md.
	66	Klamath	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Seattle, Wash.
	69	Mendota	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	Wilmington, N. C.
	67	Minnetonka	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Long Beach, Calif.
	39	Owasco	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	New London, Conn.
	70	Pontchartrain	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	Long Beach, Calif.
	42	Sebago	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	Mobile, Ala.
	44	Wachusett	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Seattle, Wash.
	40	Winnebago	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1945	Honolulu, T. H.
	65	Winona	255	43	17	1,913	S	A	TE	1	4,000	17.5	1	1946	Port Angeles, Wash.

GUNBOAT, 250-FOOT CLASS

WPG	164	Tampa [1]	250	42	15	2,075	S	B	TE	1	3,200	14.0	1	1930	Coast Guard Yard, Curtis Bay, Md.

ICEBREAKER, 290-FOOT CLASS

WAGB	83	Mackinaw	290	74	19	5,252	S	A	DE	[2] 2	10,000	16.0	1	1944	Cheboygan, Mich.

ICEBREAKER, 269-FOOT CLASS

WAGB	279	Eastwind	269	64	29	6,515	S	A	DE	2	10,000	15.0	1	1944	Boston, Mass.
	282	Northwind	269	64	29	6,515	S	A	DE	2	10,000	15.0	1	1945	Seattle, Wash.
	281	Westwind	269	64	29	6,515	S	A	DE	2	10,000	15.0	1	1944	New York, N. Y.

MISCELLANEOUS AUXILIARY

WAGR	410	Courier	339	50	21	7,500	S	F	DD	1	1,700	12.0	[3] 1	1945	New York, N. Y.
WAG	38	Storis	230	43	15	1,925	S	D	DE	1	1,800	12.5		1942	Kodiak, Alaska.

Footnotes at end of table.

Vessel list—Continued

PATROL CRAFT, 165-FOOT CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WPC	101	Ariadne	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	Key West, Fla.
WPC	103	Aurora	165	26	9	400	S	G	DD	2	1,300	13.0	1	1931	Savannah, Ga.
WPC	107	Dione	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	Freeport, Tex.
WPC	109	Hermes [1]	165	26	9	400	S	G	DD	2	1,300	13.0	1	1932	Alameda, Calif.
WPC	111	Nemesis	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	St. Petersburg, Fla.
WPC	112	Nike	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	Gulfport, Miss.
WPC	113	Pandora	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	San Juan, P. R.
WPC	114	Perseus	165	26	9	400	S	G	DD	2	1,300	13.0	1	1932	San Diego, Calif.
WPC	116	Triton	165	26	9	400	S	G	DD	2	1,300	13.0	1	1934	Corpus Christi, Tex.

PATROL CRAFT 125-FOOT CLASS

WSC	125	Active	125	24	8	295	S	M	DR	2	800	11.0	1	1926	Monterey, Calif.
WSC	126	Agassiz	125	24	8	295	S	M	DR	2	800	11.0	1	1926	Cape May, N. J.
WSC	127	Alert	125	24	8	295	S	M	DR	2	800	11.0	1	1926	Morro Bay, Calif.
WSC	129	Bonham	125	24	8	295	S	M	DR	2	800	11.0	1	1926	Coos Bay, Oreg.
WSC	130	Boutwell	125	24	8	295	S	M	DR	2	800	11.0	1	1926	Brownsville, Tex.
WSC	131	Cahoone	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Galveston, Tex.
WSC	132	Cartigan	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Panama City, Fla.
WSC	135	Diligence	125	24	8	295	S	M	DR	2	800	11.0	1	1927	San Pedro, Calif.
WSC	137	Ewing	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Alameda, Calif.
WSC	139	Frederick Lee	125	24	8	295	S	M	DR	2	800	11.0	1	1927	New Bedford, Mass.
WSC	140	General Greene	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Gloucester, Mass.
WSC	143	Kimball	125	24	8	295	S	L	DR	2	800	11.0	1	1927	Ketchikan, Alaska.
WSC	144	Legare	125	24	8	295	S	M	DR	2	800	11.0	1	1927	New Bedford, Mass.
WSC	145	Marion	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Norfolk, Va.
WSC	146	McLane	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Aberdeen, Wash.
WSC	147	Morris	125	24	8	295	S	M	DR	2	800	11.0	1	1927	San Pedro, Calif.
WSC	153	Travis	125	24	8	295	S	M	DR	2	800	11.0	1	1927	Port Everglades, Fla.
WSC	156	Yeaton	125	24	8	295	S	L	DR	2	800	11.0	1	1927	New London, Conn.
WSC	157	Cuyahoga [4]	125	24	8	295	S	M	DR	2	800	11.0	1	1927	U. S. Coast Guard Academy, New London, Conn.

OCEANGOING TUG, 213 FOOT CLASS

WAT	167	Acushnet	213	39	15	1,945	S	E	DER	2	3,000	13.0	2	1943	Portland, Maine.
	168	Yocona	213	39	15	1,945	S	E	DER	2	3,000	13.0	2	1944	Astoria, Oreg.

OCEANGOING TUG, 205 FOOT CLASS

WATF	150	Avoyel	205	39	17	1,731	S	I	DER	1	3,000	15.0	3	1945	Eureka, Calif.
	165	Cherokee	205	39	17	1,731	S	I	DER	1	3,000	15.0	2	1939	Norfolk, Va.
	153	Chilula	205	39	17	1,731	S	I	DER	1	3,000	15.0	3	1945	Morehead City, N. C.
	166	Tamaroa	205	39	17	1,731	S	I	DER	1	3,000	15.0	2	1943	New York, N. Y.

CARGO SHIP, LARGE

WAK	186	Kukui	339	50	21	7,430	S	F	DD	1	1,700	10.0	2	1945	Honolulu, T. H.

CARGO SHIP, SMALL

WAK	169	Nettle	177	32	10	936	S	K	DR	2	1,000	11.0	4	1945	Sangley Point, Philippine Islands.

CABLE LAYER

WARC	333	Yamacraw	189	37	13	1,440	S	I	RU	2	1,000	11.0	2	1942	Boston, Mass.

BUOY TENDER, 189 FOOT CLASS

WAGL	331	Heather	189	37	13	1,240	S	I	RU	2	1,000	11.0	2	1942	San Pedro, Calif.
	329	Ivy	189	37	13	1,240	S	I	RU	2	1,000	11.0	2	1942	Astoria, Oreg.
	330	Jonquil	189	37	13	1,240	S	I	RU	2	1,000	11.0	2	1942	Portsmouth, Va.
	328	Magnolia	189	37	13	1,240	S	I	RU	2	1,000	11.0	2	1942	San Francisco, Calif.
	332	Willow	189	37	13	1,240	S	I	RU	2	1,000	11.0	2	1942	Do.

See footnotes at end of table.

Vessel list—Continued

BUOY TENDER, 180-A CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WAGL	62	Balsam	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Honolulu, T. H.
	270	Cactus	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Boston, Mass.
	300	Citrus	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Ketchikan, Alaska.
	292	Clover	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Kodiak, Alaska
	301	Conifer	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Morehead City, N. C.
	277	Cowslip	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Portland, Maine
	295	Evergreen	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Boston, Mass.
	290	Gentian	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Miami, Fla.
	291	Laurel	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1942	Rockland, Maine
	302	Madrona	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Norfolk, Va.
	296	Sorrel	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Sitka, Alaska
	303	Tupelo	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1943	Toledo, Ohio
	289	Woodbine	180	37	13	1,025	S	D	DE	1	1,000	12.0	1	1944	Grand Haven, Mich.
BUOY TENDER, 180-B CLASS															
WAGL	306	Buttonwood	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1943	Honolulu, T. H.
	297	Ironwood	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Do.
	305	Mesquite	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1943	Sault Ste. Marie, Mich.
	308	Papaw	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1943	Charleston, S. C.
	307	Planetree	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1943	Honolulu, T. H.
	309	Sweetgum	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1943	Mayport, Fla.
BUOY TENDER, 180-C CLASS															
WAGL	406	Acacia	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Detroit, Mich.
	388	Basswood	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Honolulu, T. H.
	389	Bittersweet	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Kodiak, Alaska
	390	Blackhaw	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Honolulu, T. H.
	391	Blackthorn	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Mobile, Ala.
	392	Bramble	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Miami Beach, Fla.
	393	Firebush	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	St. George, Staten Island, N. Y.
	394	Hornbeam	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Woods Hole, Mass.
	395	Iris	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Galveston, Tex.
	396	Mallow	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Astoria, Oreg.
	397	Mariposa	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	New London, Conn.

WAGL	398	Redbud	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Loan to Navy (MSTS).
	399	Sagebrush	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	San Juan, P. R.
	400	Salvia	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Mobile, Ala.
	401	Sassafras	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Cape May, N. J.
	402	Sedge	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Cordova, Alaska.
	403	Spar	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Bristol, R. I.
	404	Sundew	180	37	13	1,025	S	D	DE	1	1,800	12.0	1	1944	Sturgeon Bay, Wis.
	405	Sweetbrier	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Juneau, Alaska.
	407	Woodrush	180	37	13	1,025	S	D	DE	1	1,200	12.0	1	1944	Duluth, Minn.
BUOY TENDER, OVER 150-FOOT CLASS															
WAGL	224	Juniper	177	33	9	794	S	I	DD	2	900	11.0	1	1941	St. Petersburg, Fla.
WAGL	212	Fir	175	32	12	989	S	I	DR	2	1,350	12.0	5	1939	Seattle, Wash.
	220	Hollyhock	175	32	12	989	S	I	DR	2	1,350	12.0	5	1937	Milwaukee, Wis.
	252	Walnut	175	32	12	989	S	I	DR	2	1,350	12.0	5	1939	Miami, Fla.
WAGL	203	Arbutus	175	32	12	960	S	I	REC	2	800	10.0	5	1933	St. George, Staten Island, N. Y.
WAGL	217	Hemlock	175	32	13	1,005	S	I	REC	2	800	12.0	5	1934	Ketchikan, Alaska.
WAGL	227	Lilac	173	32	11	1,040	S	J	REC	2	800	11.0	5	1933	Gloucester, N. J.
	237	Mistletoe	173	32	11	1,040	S	J	REC	2	800	11.0	5	1939	Portsmouth, Va.
	250	Violet	173	32	11	1,040	S	J	REC	2	800	11.0	5	1930	Baltimore, Md.
WAGL	215	Hawthorn	160	30	10	875	S	J	REC	1	800	7.0	5	1921	New London, Conn.
	239	Oak	160	30	10	875	S	J	REC	1	600	8.0	5	1921	St. George, Staten Island N. Y.

See footnotes at end of table.

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Vessel list—Continued

BUOY TENDER, 100- TO 150-FOOT CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WAGL	541	White Alder	133	31	9	600	S	I	DD	2	600	10.0	2	1943	New Orleans, La.
	542	White Bush	133	31	9	600	S	I	DD	2	600	10.0	2	1944	Astoria, Oreg.
	545	White Health	133	31	9	600	S	I	DD	2	600	10.0	2	1942	Boston, Mass.
	543	White Holly	133	31	9	600	S	I	DD	2	600	10.0	2	1944	Ketchikan, Alaska.
	546	White Lupine	133	31	9	600	S	I	DD	2	600	10.0	2	1942	Detroit, Mich.
	547	White Pine	133	31	9	600	S	I	DD	2	600	10.0	2	1942	Memphis, Tenn.
	544	White Sage	133	31	9	600	S	I	DD	2	600	10.0	2	1942	Woods Hole, Mass.
	540	White Sumac	133	31	9	600	S	I	DD	2	600	10.0	2	1943	Key West, Fla.
WAGL	219	Hickory	131	25	10	400	S	L	REC	1	500	10.0	5	1933	St. George, Staten Island, N. Y.
WAGL	248	Tamarack	124	30	8	400	S	H	DR	1	520	9.0	5	1934	Sault Ste. Marie, Mich.
WAGL	234	Maple	122	27	7	342	S	I	DR	2	460	10.0	5	1939	Ogdensburg, N. Y.
	238	Narcissus	122	27	7	355	S	I	DD	2	400	9.0	5	1939	Portsmouth, Va.
	255	Zinnia	122	25	7	355	S	I	DD	2	430	9.0	5	1939	Gloucester, N. J.
WAGL	208	Columbine	121	25	7	323	S	N	DE	1	240	9.0	5	1931	San Francisco, Calif.
	228	Linden	121	25	7	323	S	N	DE	1	240	7.0	5	1931	Portsmouth, Va.
	254	Wistaria	121	25	7	323	S	N	DR	1	500	10.0	5	1933	Baltimore, Md.
WAGL	304	Fern	115	31	8	350	S	D	DD	3	900	10.0	1	1942	Dubuque, Iowa.
WAGL	311	Sumac	115	30	9	350	S	D	DD	3	960	10.0	1	1944	Owensboro, Ky.
WAGL	285	Foxglove	114	30	6	358	S	D	DD	3	600	9.0	1	1945	St. Louis, Mo.
WAGL	259	Dogwood	114	26	5	230	S	I	DD	2	400	10.0	1	1940	Vicksburg, Miss.
	63	Forsythia	114	26	5	230	S	I	DD	2	400	10.0	1	1943	Sewickley, Pa.
	268	Sycamore	114	26	5	230	S	I	DD	2	400	10.0	1	1940	Cincinnati, Ohio.
		VESSEL LIST													
WAGL	408	Aster	105	30	8	450	W	M	DD	2	270	8.0	4	1943	Seattle, Wash.
WAGL	213	Goldenrod	104	24	4	193	S	G	DD	2	400	10.0	5	1938	Peoria, Ill.
	241	Poplar	104	24	4	193	S	G	DD	2	400	10.0	5	1939	St. Louis, Mo.
WAGL	205	Beech	101	23	7	255	S	I	DD	1	300	8.0	5	1929	St. George, Staten Island, N. Y.
WAGL	294	Barberry	100	24	5	178	S	D	DD	2	330	9.0	1	1943	Portsmouth, VA.
	313	Bluebell	100	24	5	178	S	D	DD	2	330	9.0	1	1945	Vancouver, Wash.
	299	Brier	100	24	5	178	S	D	DD	2	330	9.0	1	1943	Brunswick, Ga.
	293	Cosmos	100	24	5	178	S	D	DD	2	330	9.0	1	1942	St. Petersburg, Fla.
	316	Primrose	100	24	5	178	S	D	DD	2	330	9.0	1	1944	Corpus Christi, Tex.
	298	Rambler	100	24	5	178	S	D	DD	2	330	9.0	1	1944	Mobile, Ala.
	315	Smilax	100	24	5	178	S	D	DD	2	330	9.0	1	1944	New Smyrna, Fla.
	317	Verbena	100	24	5	178	S	D	DD	2	330	9.0	1	1944	Washington, N. C.
	641	Azalea [3]	100	24	5	178	S	D	DD	2	330	9.0	1		

BUOY TENDER, UNDER 100-FOOT (A) CLASS

WAGL	263	Myrtle	93	23	5	186	S	G	DD	2	330	8.0	5	1932	Corpus Christi, Tex.
WAGL	257	Bluebonnet	91	23	5	184	S	J	DD	2	200	9.0	5	1939	Galveston, Tex.
	261	Jasmine	91	23	5	184	S	J	DD	2	200	9.0	5	1935	New Orleans, La.
WAGL	265	Palmetto	90	22	4	170	S	J	DD	2	270	8.0	5	1916	Charleston, S. C.
WAGL	258	Cherry	86	24	8	202	S	I	DD	2	400	10.0	5	1932	Buffalo, N. Y.
WAGL	288	Dahlia	81	21	9	160	S	L	DD	1	500	10.0	5	1933	Detroit, Mich.
WAGL	267	Rhododendron	81	20	6	140	S	I	DD	2	240	9.0	5	1935	Seattle, Wash.
WAGL	223	Althea	81	20	4	120	S	I	DD	2	100	7.0	5	1930	Fort Pierce, Fla.
	266	Poinciana	81	20	4	120	S	I	DD	2	100	7.0	5	1930	Miami, Fla.
WAGL	310	Lantana	80	30	6	273	S	D	DD	3	450	9.0	1	1943	Keokuk, Iowa.

BUOY TENDER, UNDER 100-FOOT (B) CLASS

WAGL	286	Clematis	74	19	4	93	S	I	DD	2	150	8.0	1	1944	Galveston, Tex.
	287	Shadbush	74	19	4	93	S	I	DD	2	150	8.0	1	1944	Mobile, Ala.
WAGL	264	Oleander	73	18	5	80	S	I	DD	2	300	9.0	1	1940	Kansas City, Mo.
WAGL	256	Birch	72	18	5	75	S	I	DD	2	330	9.0	5	1939	St. Petersburg, Fla.
	260	Elm	72	18	5	75	S	I	DD	2	330	9.0	5	1937	Atlantic City, N. J.

HARBOR TUG, 110 FOOT (A) CLASS

WYT	71	Apalachee	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Baltimore, Md.
	96	Chinook	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Do.
	73	Mohican	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Norfolk, Va.
	97	Ojibwa	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Buffalo, N. Y.
	99	Sauk	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	New York, N. Y.
	98	Snohomish	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Rockland, Maine.
	72	Yankton	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Portland, Maine.
WYT	61	Kaw	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	Cleveland, Ohio.
	60	Manitou	110	27	11	370	S	G	DE	1	1,000	11.0	1	1943	New York, N. Y.

HARBOR TUG, 110 FOOT (B) CLASS

WYT	90	Arundel	110	26	11	354	S	I	DE	1	1,000	11.0	1	1939	Chicago, Ill.
	91	Mahoning	110	26	11	354	S	I	DE	1	1,000	11.0	1	1939	New York, N. Y.
	92	Naugatuck	110	26	11	354	S	I	DE	1	1,000	11.0	1	1939	Port Angeles, Wash.
	93	Raritan	110	26	11	354	S	I	DE	1	1,000	11.0	1	1939	Portsmouth, Va.

Footnotes at end of table.

Vessel list—Continued

HARBOR TUG, 110-FOOT (C) CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WYT	86	Calumet	110	25	13	309	S	I	DE	1	800	11.0	1	1934	San Francisco, Calif.
	87	Hudson	110	25	13	309	S	I	DE	1	800	11.0	1	1934	New Orleans, La.
	88	Navesink	110	25	13	309	S	I	DE	1	800	11.0	1	1934	New York, N. Y.
	89	Tuckahoe	110	25	13	309	S	I	DE	1	800	11.0	1	1935	Do.

HARBOR TUG, 85-FOOT CLASS

WYT	CG-85009		85	23	9	230	S	I	DD	1	700	10.0		1944	Coast Guard Yard, Curtis Bay, Md.

HARBOR TUG, 64-FOOT CLASS

WYT	CG-64300		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Rockland, Maine.
	CG-64301		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Southwest Harbor, Md.
	CG-64302		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Baltimore, Md.
	CG-64303		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Norfolk, Va.
	CG-64304		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Philadelphia, Pa.
	CG-64305		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Gloucester, N. J.
	CG-64306		65	19	6	65	W	D	DD	1	160	9.0	1	1944	New York, N. Y.
	CG-64307		65	19	6	65	W	D	DD	1	160	9.0	1	1943	Chicago, Ill.
	CG-64308		65	19	6	65	W	D	DD	1	160	9.0	1	1944	New York, N. Y.
	CG-64309		65	19	6	65	W	D	DD	1	160	9.0	1	1943	Bristol, R. I.
	CG-64310		65	19	6	65	W	D	DD	1	160	9.0	1	1944	New York, N. Y.
	CG-64311		65	19	6	65	W	D	DD	1	160	9.0	1	1942	Do.
	CG-64312		65	19	6	65	W	D	DD	1	160	9.0	1	1943	San Pedro, Calif.
	CG-64313		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Do.
	CG-64314		65	19	6	65	W	D	DD	1	160	9.0	1	1944	Seattle, Wash.

HARBOR TUG, 63-FOOT CLASS

WYT	CG-63300		64	20	5	69	W	G	DD	1	165	9.0	1	1936	Fire Island, N. Y.
	CG-63301		63	20	5	69	W	I	DD	1	300	10.0	1	1936	Washington, D. C.

HARBOR TUG, 56-FOOT CLASS

WYT	CG–56304	56	15	4	32	W	M	DD	1	165	9.0	1	1937	New Bern, N. C.
	CG–56305	56	15	4	32	W	M	DD	1	165	9.0	1	1937	Pilottown, La.
	CG–56306	56	15	4	32	W	M	DD	1	165	9.0	1	1937	San Diego, Calif.
	CG–56307	56	15	4	32	W	M	DD	1	165	9.0	1	1937	Seattle, Wash.

PATROL BOAT, 95-FOOT (A) CLASS

WPB	CG–95300	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Hilo, T. H.
	CG–95301	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Juneau, Alaska.
	CG–95302	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Los Angeles, Calif.
	CG–95303	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Norfolk, Va.
	CG–95304	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	New York, N. Y.
	CG–95305	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Los Angeles, Calif.
	CG–95306	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Sandy Hook Lifeboat station, N. Y.
	CG–95307	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Norfolk, Va.
	CG–95308	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	New York, N. Y.
	CG–95309	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Alameda, Calif.
	CG–95310	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Do.
	CG–95311	95	20	6	95	S	B	DR	2	2,200	19.0	1	1953	Do.

PATROL BOAT, 95-FOOT (B) CLASS

WPB	CG–95312	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	Norfolk, Va.
	CG–95313	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	Charleston, S. C.
	CG–95314	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	New London, Conn.
	CG–95316	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	Do.
	CG–95317	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	San Diego, Calif.
	CG–95318	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	Do.
	CG–95319	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	Do.
	CG–95320	95	20	7	106	S	A	DR	2	2,200	19.0	1	1955	New London, Conn.

PATROL BOAT, 83 FOOT CLASS

WPB	CG–83300	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1941	San Diego, Calif.
	CG–83303	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1941	Chincoteague, Va.
	CG–83312	83	17	6	65	W	B	DR	2	1,100	14.0	1	1941	Norfolk, Va.
	CG–83320	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1941	San Pedro, Calif.
	CG–83327	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	New York, N. Y.
	CG–83334	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Montauk, Long Island, N.Y.
	CG–83337	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	San Pedro, Calif.
	CG–83342	83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Port Isabel, Tex.

See footnotes at end of table.

Vessel list—Continued

PATROL BOAT, 83 FOOT CLASS

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
			Feet	*Feet*	*Feet*	*Tons*						*Knots*			
WPB	CG–83346		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	New London, Conn.
	CG–83359		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Sabine, Tex.
	CG–83362		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Kahului, Maui, T. H.
	CG–83366		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Santa Barbara, Calif.
	CG–83370		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Alameda, Calif.
	CG–83378		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Port Townsend, Wash.
	CG–83381		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Sandy Hook, Lifeboat Station, N. J.
	CG–83382		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Lewes, Del.
	CG–83387		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Port Isabel, Tex.
	CG–83388		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1942	Woods Hole, Mass.
	CG–83389		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Galveston, Tex.
	CG–83391		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Alameda, Calif.
	CG–83392		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Manasquan, N. J.
	CG–83394		83	17	6	65	W	B	DD	2	1,300	14.0	1	1943	Honolulu, T. H.
	CG–83397		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Alameda, Calif.
	CG–83400		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	San Juan, P. R.
	CG–83403		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Key West, Fla.
	CG–83411		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Noyo, Calif.
	CG–83412		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Monterey, Calif.
	CG–83427		83	17	6	65	W	B	DD	2	1,300	14.0	1	1943	Southport, N. C.
	CG–83428		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Port Aransas, Tex.
	CG–83435		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Norfolk, Va.
	CG–83450		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	San Pedro, Calif.
	CG–83452		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Newport Beach, Calif.
	CG–83453		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Port Townsend, Wash.
	CG–83455		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Miami, Fla.
	CG–83457		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Panama City, Fla.
	CG–83463		83	17	6	65	W	B	DD	2	1,300	14.0	1	1943	Mayport, Fla.
	CG–83464		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Cape May, N. J.
	CG–83468		83	17	6	65	W	B	DR	2	1,000	14.0	1	1943	Boston, Mass.
	CG–83481		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Port Townsend, Wash.
	CG–83482		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Nawiliwili, Kauai, T. H.
	CG–83483		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Friday Harbor, Wash.
	CG–83484		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Port Angeles, Wash.
	CG–83486		83	17	6	65	W	B	DD	2	1,300	14.0	1	1943	Provincetown, Mass.
	CG–83487		83	17	6	65	W	B	DD	2	1,300	14.0	1	1943	New Castle, N. H.
	CG–83488		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Jonesport, Maine.
	CG–83489		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	St. Petersburg, Fla.
	CG–83490		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Cape May, N. J.
	CG–83491		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Grand Isle, La.
	CG–83493		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1944	Ocracoke, N. C.
	CG–83497		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Charleston, S. C.
	CG–83499		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Pascagoula, Miss.

	CG–83501		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Charleston, S. C.
	CG–83503		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Nantucket, Mass.
	CG–83504		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Crisfield, Md.
	CG–83506		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Charlotte Amalie, V. I.
	CG–83518		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1944	Cape May, N. J.
	CG–83523		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Bellingham, Wash.
	CG–83524		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1944	Morgan City, La.
	CG–83527		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1943	Tacoma, Wash.
	CG–83529		83	17	6	65	W	B	GAS	2	1,200	14.0	1	1944	Cape May, N. J.
		BUOY BOAT, 65-FOOT CLASS													
WD	CG–65024–D		65	14	4	46	W	M	DD	1	160	9.0	4	1944	Charlevoix, Mich.
	CG–65025–D		65	14	4	46	W	M	DD	1	160	9.0	4	1944	New Orleans, La.
	CG–65026–D		65	14	4	46	W	M	DD	1	160	9.0	4	1945	Do.
	CG–65027–D		65	14	4	46	W	M	DD	1	160	9.0	4	1945	Portsmouth, Va.
	CG–65028–D		65	14	4	46	W	M	DD	1	160	9.0	4	1945	South Portland, Maine.
WD	CG–65302–D		65	14	4	68	S	G	DD	2	330	12.0	1	1942	The Dalles, Oreg.
	CG–65303–D		65	17	4	68	S	N	DD	1	160	9.0	1	1946	Paris, Tenn.
	CG–65304–D		65	17	4	68	S	N	DD	1	160	9.0	1	1946	Chattanooga, Tenn.
	CG–65305–D		65	17	4	68	S	N	DD	1	160	9.0	1	1946	Nashville, Tenn.
WD	CG–65400–D		65	17	5	71	S	D	DD	2	400	11.0	1	1954	San Francisco, Calif.
	CG–65401–D		65	17	5	71	S	D	DD	2	400	11.0	1	1954	Petersburg, Alaska.
		LIGHTSHIP													
		ASSIGNMENT													
WAL	189	Diamond Shoal	128	30	11	600	S	A	DD	1	600	10.0	1	1946	Morehead City, N. C.
	196	Nantucket	128	30	11	600	S	A	DD	1	600	10.0	1	1946	Woods Hole, Mass.
	504	Relief	130	29	12	578	S	I	REC	1	380	10.0	5	1904	San Francisco, Calif.
	505	Relief	129	30	12	558	S	I	DD	1	300	8.0	5	1904	St. George, Staten Island, N. Y.
	506	Barnegat	129	30	12	558	S	I	DD	1	310	7.0	5	1904	Barnegat Light, N. J.
	508	Relief	130	29	13	706	S	I	REC	1	350	9.0	5	1904	Seattle, Wash.
	509	Relief	135	29	13	683	S	I	DD	1	300	7.0	5	1904	Charleston, S. C.
	510	Boston	135	29	13	683	I	I	DD	1	500	11.0	5	1907	Boston, Mass.
	511	Buzzards Bay	135	30	13	683	S	J	DD	1	315	10.0	5	1907	Woods Hole, Mass.
	512	Scotland	135	29	12	683	S	I	DD	1	300	9.0	5	1907	St. George, Staten Island, N. Y.
	513	Umatilla Reef	135	29	12	683	S	I	DD	1	350	9.0	5	1907	Seattle, Wash.
	515	Relief	135	29	13	685	S	I	DD	1	400	11.0	5	1908	Portsmouth, Va.
	519	Relief	108	23	12	385	S	I	DD	1	368	7.0	5	1912	Cape May, N. J.
	523	Blunts Reef	133	30	13	630	S	H	DE	1	350	8.0	5	1929	Eureka, Calif.
	524	Stone Horse	102	25	12	360	S	I	DD	1	300	6.0	5	1916	Chatham, Mass.
	525	Brenton Reef	102	25	12	360	S	I	DD	1	300	6.0	5	1915	Newport, R. I.
	526	Lake Huron	97	24	11	310	S	I	DR	1	340	8.0	5	1921	Port Huron, Mich.

See footnotes at end of table.

Vessel List—Continued

LIGHTSHIP—Continued

Type	No.	Name	LOA	BEAM	DR	DISP	HULL	E	PROP	SCR	SHP	SP	ACQ	BLT	Permanent station
WAL			*Feet*	*Feet*	*Feet*	*Tons*						¼*nots*			
	528	Relief	132	30	16	775	S	I	DD	1	500	8.0	5	1923	Boston, Mass.
	529	Winter Quarter	132	30	16	775	S	I	DD	1	500	8.0	5	1923	Chincoteague, Va.
	530	Five Fathom Bank	133	30	17	775	S	I	DD	1	500	9.0	5	1923	Cape May, N. J.
	531	Savannah	133	30	16	775	S	I	DD	1	500	8.0	5	1923	Savannah, Ga.
	532	Cross Rip	133	30	16	775	S	I	DD	1	500	8.0	5	1923	Woods Hole, Mass.
	533	Portland	133	30	16	780	S	I	DR	1	450	8.0	5	1926	Portland, Maine.
	534	Relief	149	31	16	1,000	S	I	REC	1	600	10.0	5	1936	Boston, Mass.
	535	Swiftsure Bank	133	30	13	680	S	I	DE	1	300	9.0	5	1930	Seattle, Wash.
	536	Pollock Rip	133	30	13	680	S	I	DE	1	350	8.0	5	1930	Chatham, Mass.
	537	Frying Pan Shoal	133	30	13	680	S	I	DE	1	350	8.0	5	1930	Morehead City, N. C.
	538	Chesapeake	133	30	13	680	S	G	DE	1	350	8.0	5	1930	Portsmouth, Va.
	539	Cornfield	115	26	13	412	S	L	DD	1	300	9.0	5	1938	New London, Conn.
	604	Columbia	128	30	10	540	S	A	DD	1	610	10.7	1	1950	Astoria, Oreg.
	605	Overfalls	128	30	10	540	S	A	DD	1	610	10.7	1	1950	Lewes, Del.
	612	San Francisco	128	30	10	540	S	A	DR	1	610	10.7	1	1950	San Francisco, Calif.
	613	Ambrose	128	30	10	540	S	A	DR	1	610	10.7	1	1950	St. George, Staten Island, N. Y.
		TRAINING VESSEL													
WIX	327	Eagle	295	39	16	1,634	S	K	DD	1	700	10.0	2	1936	U. S. Coast Guard Academy New London, Conn.
WIX	70001	Petrel	70	15	10	35	W	------	DD	1	50	7.5	7	1938	Do.
WIX	65016	Curlew	65	14	9	27	W	------	DD	1	60	6.5	7	1926	Cape May, N. J.
WIX	157	Cuyahoga	125	24	8	295	S	M	DR	2	800	11.0	1	1926	U. S. Coast Guard Academy New London, Conn.

[1] In storage.
[2] Twin screw with bow propeller.
[3] Operated by U. S. State Department.
[4] Class changed to WIX training vessel.
[5] Building.

The CHAIRMAN. I would like for the record to contain a letter from the Committee of American Steamship Lines supporting this legislation, and it will be included in the record at this point.

(The letter referred to follows:)

COMMITTEE OF AMERICAN STEAMSHIP LINES,
Washington, D. C., January 23, 1958.

Hon. HERBERT C. BONNER,
Chairman, Merchant Marine and Fisheries Committee,
House of Representatives, Washington, D. C.

DEAR CHAIRMAN BONNER: We are happy to respond to your request for the views of the Committee of American Steamship Lines on H. R. 9196, H. R. 9978 and H. R. 10122 to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard.

Obviously, we are not in a position to comment on the priority which should be given such a project or its relative importance with respect to the programs for the application of nuclear propulsion to surface ships or submarines.

But we believe that the construction of such a vessel as is proposed would make a distinctive contribution to our maritime technology. The problem of fuel supply is particularly acute in the polar regions and imposes severe limitations on maritime operations there. Therefore utilization of nuclear propulsion in lieu of traditional fuels would appear to have unique advantages in these areas. The construction of a nuclear-powered icebreaker would not only provide a ship of unusual capabilities but would furnish a floating laboratory in which the apparent advantages of nuclear propulsion could be tested under the most adverse conditions.

Information gained from its operation will supplement that which will be obtained from the world's first nuclear-powered merchant ship, the nuclear ship *Savannah*, and would in our opinion, be of great value to our member lines who are now programing vessel replacements spanning the next 10 to 15 years.

While we have not discussed the matter with the United States Coast Guard, it would seem desirable to us that this agency should have an opportunity to gain experience in the adaptation of nuclear power to ocean transport.

For these reasons, we favor the proposed legislation and would appreciate the opportunity you have given us to express our views.

Very truly yours,

ALEXANDER PURDON.

The CHAIRMAN. If it is convenient to the witnesses and the members of the commitee, Admiral Mumma is here, I understand, and if the committee members desire to run until 1 o'clock—the House not being in session—we can complete these witnesses today.

Admiral MUMMA. My statement is very short, Mr. Chairman.

The CHAIRMAN. Admiral Mumma, we shall be glad to hear from you at this time.

STATEMENT OF REAR ADM. A. G. MUMMA, UNITED STATES NAVY, CHIEF OF NAVY'S BUREAU OF SHIPS, DEPARTMENT OF THE NAVY

Admiral MUMMA. Mr. Chairman, I am Rear Admiral A. G. Mumma, Chief of the Bureau of Ships, Navy Department, and Coordinator of Shipbuiding, Conversion and Repair for the Department of Defense.

I am pleased to have this opportunity to testify on H. R. 9196, a bill to authorize construction of a nuclear-powered icebreaking vessel for operation by the Coast Guard, and for other purposes.

The Navy has made preliminary design studies of a nuclear-powered icebreaker. Such a ship would have some worthwhile military advantages, including increased endurance, and slightly increased power for icebreaking purposes.

Last December it was reported that the Soviet Union had launched a nuclear-powered icebreaker. However, it is understood that the nuclear powerplant was not installed at the time of launching. It is easy to launch a ship hull, but what is inside is the important thing. In its quest for ice-free trade routes, it is only natural that the Soviet Union should give first priority to applying nuclear power to an icebreaker.

The United States does not have a large contiguous ice mass as Russia does, hence it is doubtful if we would be justified in giving top priority to a nuclear-powered icebreaker.

This country has a great lead over Russia in the application of nuclear power for ships, not only for submarines but for surface warships as well. We have embarked on a rapidly expanding long-range program for incorporating nuclear power into our major combatant ships. At present, there are building or authorized 16 nuclear-powered submarines, in addition to 3 which are already operational, and 2 nuclear-powered surface ships, a guided missile cruiser and a nuclear-powered attack aircraft carrier. As you know, there is now before the Congress a supplemental budget request for fiscal 1958 which includes funds for construction of three nuclear-powered fleet ballistic missile submarines. These submarines are urgently required to bring the Polaris missile system into operational use, to add new striking power to our country's retaliatory capabilities. Insofar as the Navy is concerned, the advantages of nuclear power are greater in warships than in auxiliary-type vessels. Nuclear technology is expanding and additional shipyards, engineers, and other personnel are being indoctrinated in nuclear techniques. So it cannot be said that the fundamental capacity does not exist. The use of this capacity, however, is highly important to our national security.

A most important factor is cost. In 1954, the Navy completed the *Glacier* (AGB 4), an excellent prototype icebreaker in the postwar period, at a total cost of $31 million. The *Glacier* has had extended Antarctic duty in operation Deep Freeze and has many times over proved the excellence of her design, seakeeping qualities, and icebreaking capacity. The *Glacier* is highly useful in supplying Arctic and Antarctic defense installations and in conducting surveys. The cost of building a nuclear-powered icebreaker, in accordance with Navy standards, is estimated at some $40 million to $60 million, depending on the design and size of the ship. Such a ship would be very valuable to the Navy in wartime. However, it is considered that the additional cost at the present time is sufficient to offset the advantages of such a ship over a conventionally powered icebreaker.

H. R. 9196 authorizes the Treasury Department to make use of licenses, information, services, facilities, and employees of any other agency of the Government, with the approval of the Secretary of the Treasury. This, in effect, would give the project an overriding priority. The Navy, in particular, objects to this provision and suggests that it be amended to require also the prior approval of the agency or agencies from which assistance would be sought.

That completes my statement, Mr. Chairman.

The CHAIRMAN. Of course, Admiral, in the first place it is not the desire of this committee to interfere with the program of the national defense or delay it.

Did you hear the testimony that was given by the first three witnesses?

Admiral MUMMA. No, sir; I was not present. I heard the testimony given by the Coast Guard just now, sir. I read accounts of the other testimony.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. No questions.

The CHAIRMAN. Mr. Allen?

Mr. ALLEN. I got the idea in the past few years that the capacity to build nuclear powerplants has been increasing and spreading out. I am curious to know whether we are reaching a point where in a sense we can be in production of a typical plant for ships of this size.

Admiral MUMMA. It so happens that we have a large number of submarines in which the powerplants and the reactors are identical. So to that degree we have achieved what might be called reasonably good-sized production runs for nuclear power.

The base is being broadened by competitive methods to the maximum extent we can by insuring that we have multiple sources for items such as reactor component parts, pumps, that sort of thing, that are vital to the reactor part of the program.

So that we have a feeling that the innate capacity of the country to absorb an increase in this field is great. So that I do not think this single icebreaker would be any tax on the capacity by any stretch of the imagination, Mr. Allen.

Mr. ALLEN. What is the critical feature? Would it be the fuels or metals involved or the lack of capacity at the moment?

Admiral MUMMA. From the Navy's point of view I think the critical item would be the cost at this time. The conventionally powered icebreaker does a pretty good job for us, except for the items visualized in this discussion this morning of being frozen in when obviously the nuclear power gives you a tremendous advantage over a conventionally powered icebreaker.

We would find that it might be more advantageous to have 2 icebreakers than to have 1 that cost as much as the nuclear-powered one would probably cost at the present time. I would anticipate that in a year or two the fundamental cost relative to other costs should be coming down.

Mr. ALLEN. If we wanted to build such an icebreaker starting it now and getting it out with pretty full consideration of its configuration to take care of all the science and exploration, et cetera, that we have talked about, how long would it take from now until it was in operation?

Admiral MUMMA. I would estimate that such an icebreaker could be designed and built using present reactor technology in a period of something between 2 and 3 years depending upon the complication of design.

Mr. ALLEN. How long would it take to get the people together as a matter of practice on what should go into the accommodations of it?

Admiral MUMMA. That is the difficult part of any such design, actually fixing on a design. This process ordinarily takes us in the Navy for a combatant-type ship something from 6 months to a year. When we dream up a need for a ship, it evolves over that period of time into a firm design and by that time we are ready to go ahead and place contracts.

Mr. ALLEN. Would that be in addition to the time you mentioned?

Admiral MUMMA. I do not think you need to take all that time because icebreakers are now pretty well evolved, I would say. When I am talking about these new ships, I am talking about a different kind of a ship with guided missiles whereas ships did not have guided missiles heretofore. I am sure the icebreaker would be fundamentally quite similar to what we now consider an icebreaker should be, maybe with some additional space for these scientific endeavors. But I would have a feeling that the machinery, equipment, and so forth, could be procured while you were making up your mind as to some of the details of the design of the ship itself.

Mr. ALLEN. In your opinion could the more or less conventional icebreaker be increased in size so as to give both the additional accommodations, additional cargo space, and additional fuel capacity of a conventional nature so as to equal, if necessary, the performance of a nuclear-powered icebreaker?

Admiral MUMMA. Yes, you can go part way with conventional increase in fuel capacity. However, I do not believe that you will ever overtake the nuclear powerplant. It would be completely unwieldy as a ship from that point of view. In many of our naval ships we have, shall we say, maximized their endurance in order to insure they will not become so obsolete so quickly when compared with nuclear-powered ships. We are doing that at the present time, increasing the endurance and radius of our conventional ships.

Mr. ALLEN. Thank you.

The CHAIRMAN. Before asking any further questions, would you enlarge on this last paragraph:

> The Navy, in particular, objects to this provision and suggests that it be amended to require also the prior approval of the agency or agencies from which assistance would be sought.

I have a general idea of what you mean but I would like to have it on the record just what you have in mind there.

Admiral MUMMA. For example, let us assume that the Secretary of the Treasury without consultation with the Secretary of the Navy or the Secretary of the Navy's approval should decide that he wanted Admiral Rickover's group transferred to the Treasury Department to do this job. I would object rather strenuously to that, Mr. Chairman.

The CHAIRMAN. That arose during our discussion of the cargo-passenger combination vessel. We assured you then we did not intend to have Admiral Rickover turned over to the Maritime Administration. It was only his advice and counsel that we sought in the hearing. As Admiral Richmond said in his testimony, you and other agencies would be consulted. The Navy of course would be consulted in respect to this.

You heard Admiral Will's testimony, did you not?

Admiral MUMMA. No, sir.

The CHAIRMAN. You are vitally interested in supplying the DEW line?

Admiral MUMMA. Yes, I know about his testimony.

The CHAIRMAN. Admiral Will testified here that they were going to turn over the supplying of the DEW line to commercial ship operators. The question was asked of Admiral Richmond as to what

would be his responsibility in that case. Are you going to direct the Coast Guard, should that take place, to provide proper navigation assistance to the commercial ships that supply the DEW line?

Admiral MUMMA. In view of my primary interest in the technical side of this business, I think that answer should really be supplied by the Chief of Naval Operations, sir, because of his overall view of this problem.

The CHAIRMAN. It is a fair question?

Admiral MUMMA. I could have a statement supplied for the record if you like.

The CHAIRMAN. I just wanted that to be in the record at this time and I wanted to assure you that on this language in the last paragraph that we have no idea of entering the nuclear field because another committee in Congress is very jealous of that prerogative at the present time. We do not want to get into a battle with them or take it away from such agency as you or the people you have in your agency.

Any questions, Mr. Gross?

Mr. GROSS. Am I correct in assuming from your statement with reference to the Russian's nuclear-powered icebreaker that you would be opposed to conversion of any, if it were possible, conversion of any existing icebreaker to atomic power?

Admiral MUMMA. No, sir; I do not wish to be put in that, shall we say, somewhat obstructionist point of view.

Mr. GROSS. I do not want to put words in your mouth.

Admiral MUMMA. What I mean to say is conversion of an existing icebreaker I do not believe would be desirable. I think for a nuclear-powered icebreaker you would probably want to build a new one because there would be enough difference in the tankage and arrangement of the ship that I am sure a conversion would not be completely satisfactory.

Therefore, I do feel however that the Russian utilization of an icebreaker of this type where they might get locked into the complete northern half of their whole coastline on an almost continuous basis would be a far more urgent priority if I had that same immediate problem to design for in the United States itself.

Admitting that Canada, to a large degree, is a part of our extended boundary in this way of thinking, and we do cooperate very greatly with Canada in this area, there is some military advantage obviously of having nuclear power.

Mr. GROSS. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Rivers?

Mr. RIVERS. You do not think there is enough know-how? You do not think from your last paragraph there is enough existing know-how in the construction of nuclear propelled vessels outside of the Navy to cause competition or bring about the cannibalizing of what exists in the Government? That is, the Navy.

Admiral MUMMA. I think there is adequate know-how and it is increasing all the time, particularly if they utilize some of our technology that is now getting pretty well disseminated throughout the industry. So that the AEC has a large amount of this information available, not only in the AEC itself but in their contractors. The same is true of their various subgroups such as the Maritime Reactor Division of the AEC.

We are not attempting to play dog in the manger in this regard. We feel if it is done by the Coast Guard, as contemplated by this bill, that we would be glad to help them in any fashion that we could or if they wished to do a completely separate job with other agencies and without too much consultation with us, that would also be possible.

Mr. RIVERS. You do not want any mandatory provision which would give them the right to take what you have?

Admiral MUMMA. That is right, because once it is written into law it makes it very difficult.

Mr. RIVERS. That is your position?

Admiral MUMMA. Yes.

Mr. RIVERS. Speaking of the Rickover group for the record, who was in charge of the task force that developed the *Nautilus*? What was his name?

Admiral MUMMA. Well, that is a difficult question to answer——

Mr. RIVERS. It is not difficult.

Admiral MUMMA. Because of the fact that the *Nautilus* itself——

Mr. RIVERS. Who had the overall responsibility?

Admiral MUMMA. The overall responsibility for the design of the ship rested in the Bureau of Ships.

Mr. RIVERS. Who was in charge of that program?

Admiral MUMMA. At that time there were various chiefs of bureaus.

Mr. RIVERS. Were you not in charge of it?

Admiral MUMMA. Not at that time.

Mr. RIVERS. Who did Admiral Rickover work for when that thing developed? Was he not working for you?

Admiral MUMMA. It was early in the program and the *Nautilus* was not in the picture at that time.

Mr. RIVERS. You disclaim any responsibility for the *Nautilus*?

Admiral MUMMA. Not complete; no, sir.

Mr. RIVERS. Why do you not answer my question? The world gets the impression that Admiral Rickover created, had charge of, and solely gave birth to the *Nautilus*. Is that true or not?

Admiral MUMMA. It is not a completely true impression. The reason for this is that the *Nautilus* ship itself was designed by the Bureau of Ships. The reactor powerplant was fundamentally developed by Admiral Rickover and his group. As a matter of fact, we have in this room right now one of the men who had a great deal of responsibility in connection with that and that is Mr. Roddis now of the AEC.

Mr. RIVERS. What was your job?

Admiral MUMMA. At the time of the beginnings of the *Nautilus*, very beginnings before it even became a ship, I was in charge of the machinery coordinating aspects of the ship design. This goes back from 1947 until I left the Bureau in 1949. During that time some of this work was done. As a matter of fact, at that time then Lieutenant Commander Roddis worked for me. He was the head of our Nuclear Power Division in the Bureau at that time.

Mr. RIVERS. Without detracting from the great genius of Admiral Rickover, I think the modesty you have exemplified is a great tribute to you as a gentleman.

Admiral MUMMA. Thank you, Mr. Rivers.

Mr. RIVERS. That is all.

The CHAIRMAN. We would like to clear up this last paragraph. What is the language in the bill before us? We tried to draw this bill to get your favorable reaction and we want to make it tasty to those we are depending on for assistance. We say, "Avail itself of the use"; is the word "avail" the one?

Admiral MUMMA. I believe that the difficulty is that it makes the determination unilateral by the Secretary of the Treasury. I think that is the fundamental difficulty. I would suggest this.

The CHAIRMAN. Would you offer the language that would make it satisfactory?

Admiral MUMMA. I would say, "With the approval of the Secretary of the Treasury and the agency or agencies from which assistance would be sought." I think with the addition of that one phrase it would make it——

Mr. RIVERS. Not objectionable to you?

Admiral MUMMA. It would not be objectionable to us, sir.

The CHAIRMAN. Would the agencies be willing to collaborate in the construction?

Admiral MUMMA. That is pretty obvious, I am certain.

The CHAIRMAN. Is it not recognized, Admiral, that in the forward march of progress, science, and other things, that we must utilize this energy as far as possible and that this is a field in which aid would be given to science and national defense and other things we are interested in with the development of a ship of this kind?

Admiral MUMMA. This is assuming that there is additional demand over and beyond the military demand for such a ship.

The CHAIRMAN. I take it that you are favorable because the Navy has made preliminary designs and studies so you had it in your mind yourself to do this.

Admiral MUMMA. Yes, sir; they happen to be classified at the moment because ordinarily these preliminary designs are classified but I have two such studies actually here with me, which I would not like to be made part of the record, but if you would like to examine them in closed session I would be glad to make them available to you.

The CHAIRMAN. Is it the idea of the Navy to operate them?

Admiral MUMMA. These are fundamentally naval designs for a nuclear-powered icebreaker that the Navy would operate.

The CHAIRMAN. Does the Navy feel this is their field in season and out of season?

Admiral MUMMA. I do not think there is much point of difference of opinion there. We feel it is a field in which both the Coast Guard and Navy now operate and if the Coast Guard could provide sufficient service in all aspects of this field, I am certain that the Navy would be quite receptive to that concept.

The CHAIRMAN. The Navy eventually has the Coast Guard anyway, so the Navy would be interested in seeing the Coast Guard in this field; would they not?

Admiral MUMMA. I would think so. I might add one point, that the cooperation between the Navy and Coast Guard has been absolutely superb over the years in the connection I have had with the Navy.

The CHAIRMAN. I am delighted to hear you say that. I wish the Navy would show a little more interest with the Secretary of the Treasury in providing sufficient funds to the Coast Guard to keep up their tools that they are required to have to carry out the missions that are delegated to them by statute. I am beginning to believe that the Coast Guard just simply does not have enough tools. Your splendid organization just gets everything in the world you want when you come to Congress.

Admiral MUMMA. I do not have that same impression, Mr. Chairman.

The CHAIRMAN. Your brothers in the Coast Guard, in the case of emergency come in shoulder to shoulder with you, I just think the Navy should show more interest in the Coast Guard through the Treasury because I think the Treasury has a very shortsighted view of the requirements of the Coast Guard. I have gone over the necessary ships and other things that the Coast Guard has and it is appalling. It looks to me as though in 2 or 3 years they are just going to fall to pieces.

Mr. Mailliard, do you have any questions?

Mr. MAILLIARD. Admiral Mumma, your report does not really take a position. You object to certain terminology. You say this would be a valuable ship. You do not really say whether you are for or against the bill.

Admiral MUMMA. It is not, as you know, an administration-sponsored bill and the Navy does not have funds committed in any budgets as of now for this type of operation and I understand neither has the Coast Guard. So that it would make it extremely difficult for us to take a strong position on this bill.

Mr. MAILLIARD. You hang a sort of halfhearted opposition to the bill as I see it on the price tag. This is an authorization bill, not an appropriation bill. Would it be inconsistent with your usual procedures to support the purpose of the bill recognizing that the battle for the money is a separate battle?

Admiral MUMMA. I would have to qualify such support by stating it would be dependent upon a determination of a national interest over and above the Navy's particular interest in such a ship. Obviously we have had interest in a ship or we would not have been studying them for some period of time. But we do find that we have not been able to justify it for our purposes alone.

Mr. MAILLIARD. In other words, as a fleet unit, the cost does not balance with your other requirements?

Admiral MUMMA. That is correct.

Mr. MAILLIARD. But you said it might be possible in the national interest that with the increased cost in the polar areas and the need for scientific information and so forth that this might give it enough national priority to justify the vessel.

Admiral MUMMA. I certainly could visualize that possibility, Mr. Mailliard.

Mr. MAILLIARD. Do you think the committee ought to get an expression of opinion from Chief of Naval Operations who, after all, would also have a responsibility to determine how urgent it is that we collect data on weather and the sea bottom, and various navigational systems that might be required, for instance, of submarines going under the Polar Cap?

Admiral MUMMA. I would suspect that the scope might well go beyond his ken into the general fields of science as contemplated by the thinking behind this bill.

Mr. MAILLIARD. Well, I can see that, but as far as I know you are the only witness we have scheduled from the Navy Department, and you are speaking more on the technical side of it, and certainly, or at least I am asking you your opinion as a naval officer, whether we should not also have the Navy's opinion from a man of operational responsibility who will be concerned, for instance, with the navigation problems of a submarine operating under an icecap.

We believe, based on previous testimony which you did not hear, that such a vessel could collect data which might greatly enhance the ease of precise navigation under an icecap.

In other words, what I am getting at is I gather from your statement that we really should not consider this particularly as an overall Navy stand on the bill.

Admiral MUMMA. This position has been coordinated within the Navy, sir.

Mr. MAILLIARD. It has?

Admiral MUMMA. Yes, sir, and my statement has been reviewed and is a Navy position.

Mr. MAILLIARD. Do you know whether any consideration was given to these other factors?

Admiral MUMMA. It is possible that they may not have been given the amount of consideration that you would like to have had on certain facets and, maybe, this testimony before this committee has brought out at this time additional facets that should be considered. If that is the case, it might be wise to ask for an operational evaluation of the utilization of such a ship.

Mr. MAILLIARD. Mr. Chairman, I would make the suggestion that we ask the Department of the Navy to have someone in the Office of the Chief of Naval Operations read the testimony we have already received showing that we are considering this vessel in the light of much more than strictly wartime military requirements, and then ask them if they want to upgrade their priority.

The CHAIRMAN. That should be directed to Admiral Burke?

Admiral MUMMA. To the Chief of Naval Operations; yes, sir, Admiral Burke.

Mr. RIVERS. It would be directed to the Chief of Naval Operations. They are responsible to him.

Your plans, Admiral, for an icebreaker which you say you have two separate ones, is in the overall program of the Navy's transition from steam turbine to nuclear propulsion for all categories of your fleet units; is that right?

Admiral MUMMA. Well, we would put a nuclear-powered icebreaker ahead of other auxiliary ships, generally speaking, in priority, because it has further need for endurance than does a ship that, for example, goes from one point on the globe to another point on the globe and returns, and where it can fuel at both ends. That is easy, but where it has to stay out like, for instance, a carrier force, or warships, or possibly an icebreaker, we feel that the priority climbs when those are fundamental requirements.

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Mr. MAILLIARD. That being true, why do you not give it higher priority?

Admiral MUMMA. It has fairly high priority, but not that high.

Mr. RIVERS. Not high enough to get out of the Merchant Marine and Fisheries Committee.

Admiral MUMMA. Not high enough to get out of our money limitation.

The CHAIRMAN. I appreciate your statement, and agreement that you have expressed that in the light of the testimony that has been offered to this committee which Mr. Mailliard developed—and it has been most interesting—that we ask the Navy to take another look and see if it cannot come in for a little stronger endorsement.

Mr. Pelly, do you have any questions?

Mr. PELLY. Mr. Chairman, I would like to see if, maybe, Admiral Mumma could fill in one gap which I think Mr. Thompson was exploring earlier:

Would it be possible for you to give us a statement for the record—a thumbnail formula, maybe—as to the difference in space between a conventional powerplant, together with the conventional fuel storage, necessary storage tanks, as against the overall nuclear propulsion plant with reference to space?

Admiral MUMMA. This would depend to a considerable extent upon the assumptions that were made in the design but, obviously, one major point in icebreaker design that is important is the strength of the hull and the thickness of the plating and the frame that supports that plating is very sturdy construction.

Therefore, the frames are very deep, and in a conventional icebreaker that space is available for stowing of fuel oil.

In a nuclear-powered icebreaker, that space is not available for anything because you do not have the fuel oil and it is not good, usable cargo space. Therefore, to a considerable degree, you have to place the reactor and its machinery internally, and we must remember that the reactor and its machinery weighs more at the present time, generally speaking, than does the conventional powerplant, plus its fuel.

So, with the fuel distributed around the ship all over in the skin of the ship, in the conventional ship you can see that the minute you concentrate this wide a space into a reactor and its machinery in the center of the ship, you have a necessity, generally speaking, for bulging out the sides of the ship. You do not use what would be otherwise wasted space so that the ship, generally speaking, would be a little bit larger, a little bit more costly in itself without the additional cost of the nuclear plant.

I do not know whether this completely answers your question, Mr. Pelly, but it is the kind of a problem we also have in naval ships, though it is accentuated, I think, a little bit in the case of an icebreaker.

Mr. PELLY. One could assume from what you said, then, there would be no overall savings in space when comparing one against the other; is that correct?

Admiral MUMMA. I actually think there is a reduction in space.

Mr. PELLY. With reference to any such icebreaker, it does not mean it would not carry petroleum products to the north, we will say, is that correct?

Admiral MUMMA. If you did carry petroleum products as payload in this additional between-framing space that could be used for tankage, there is no reason in the world why that would not be advantageous.

Mr. PELLY. That would be a cooperative basis for economizing with other agencies that might be served by the Coast Guard or whoever was operating it, and serving it.

Admiral MUMMA. It is a rather expensive tanker. You can build tankers pretty cheaply, as you know, Mr. Pelly.

Mr. PELLY. It would be very much of a savings, however, if it could survive in the ice, as against the conventional type of tanker. We could save a lot of money on the DEW line operation; could we not?

Admiral MUMMA. No, sir.

Mr. PELLY. Thank you.

Mr. MAILLIARD. Also, if we were balancing the cost of using this in emergency conditions as a tanker, it would be an expensive tanker, but if you transported your fuel by air, that would be pretty expensive also?

Admiral MUMMA. Yes, sir; it would be a cheaper tanker than carrying it by air. I can subscribe to that.

Mr. PELLY. The question arose, however, I think more in connection with the number of personnel which could be properly housed when comparing one type of breaker as against another. The question which rose when Mr. Thompson raised his point was as to the number of, maybe, scientific personnel which could be accommodated on this ship when it was in polar regions.

Would you say that that space could be utilized to advantage for housing personnel?

Admiral MUMMA. You see, the space might be somewhat localized for the powerplant so that you would have considerable additional space fore and aft which, because it is a bigger ship than the one you would be considering conventionally powered, could be used for such a purpose.

As a matter of fact, the number of personnel that would be required in such a ship would not be vastly different from a conventionally powered ship, and I would suspect that actually they are not space-limited ships now, from a fundamental point of view. They have space in them.

The CHAIRMAN. Mr. Pelly, will you yield to me before you get away from that cargo aspect?

Mr. PELLY. Yes, sir.

The CHAIRMAN. It was testified by Dr. Siple, who has had extensive Arctic and Antarctic experience, that 60 percent of all cargo in exploration missions has to be fuel at a relative cost of $10 per gallon.

You spoke of building a tanker so much cheaper and you also spoke of the storage of fuel in parts of the ship that could not be used otherwise.

With fuel costing this amount as compared with a nuclear ship, what would be the balance?

Admiral MUMMA. Well, I think that is a very complicated logistic study, of course, Mr. Chairman, but assuming that the icebreaker would carry its own fuel to and back in the conventional case and that it bought it in the United States at a reasonable price and not at the $10-a-gallon figure——

The CHAIRMAN. That is meant to reflect the cost of getting it there, airdrop and so forth.

Admiral MUMMA. Certainly if you are going to fuel anything at a scene far away and it costs $10 a gallon to get it there, it certainly would be very interesting, because nuclear power would not cost anything like that.

The CHAIRMAN. That is why it looks as if it might be well if we referred this record back to your Department for study.

Admiral MUMMA. Yes, sir.

The CHAIRMAN. Any further questions?

Mr. PELLY. In previous testimony we were told that heretofore we had never been able to locate harbors in Marie Byrd land, nor had we been able to take ships in there. It struck me that an icebreaker of this type would be the one ship that might go in and provide fuel. You could not take supply vessels into that post, which we apparently intend to go in and maintain a base even after the Geophysical Year is over. Therefore, it may have a very useful purpose.

Admiral MUMMA. I would have to defer to the Coast Guard or experienced Navy personnel as to whether it would have substantially greater icebreaking capability than the conventional type.

Mr. PELLY. I mean not only breaking ice but being able to take in at the same time petroleum and other supplies needed in such a post that otherwise would have to be airlifted.

Admiral MUMMA. If you do not have that fuel in the icebreaker, it gives you a cargo advantage. There is no question about that.

Mr. PELLY. That would seem to be the ideal spot where that advantage could be exploited.

That is all, Mr. Chairman.

The CHAIRMAN. Any further questions?

Mr. GROSS. Do I get the idea that the present number of icebreakers, in your opinion, is sufficient short of a war emergency?

Admiral MUMMA. I think that is a problem that should be deferred to the operational group, Mr. Gross, because of the fact that with 8 or 9 icebreakers in operation at the present time, whereas prewar we had none, it is a matter of evaluating what you want to do; and, of course, we are far more committed to the Arctic and Antarctic than we were before World War II, so it is a very difficult question to answer. We obviously have close to a balanced number, or we would be in for more icebreakers immediately. We wanted to have a prototype built, and that is why we built the *Glacier*, so that we do have a design that can be produced in quantity that is an improvement over the World War II icebreaker.

Mr. GROSS. That is an oilfired icebreaker?

Admiral MUMMA. That is an oilfired icebreaker. The next step might be a design of a conventionally powered icebreaker or it might be a nuclear-powered icebreaker.

Mr. GROSS. I got the impression from the pictures shown here that the conventional icebreaker has an ability to subsist on its fuel supply for a long time.

Admiral MUMMA. It depends on the amount of steaming it has to do and how long it is on station.

Mr. GROSS. We were told during the running of the picture this morning that there was no fear for the vessel from the standpoint of

fuel or subsistence of the crew. The fear was it would be carried by the icepack into shore.

Admiral MUMMA. They carry many times the provision and fuel supply that ordinary ships do.

The CHAIRMAN. Any further questions?

Mr. MAILLIARD. I am of the impression there may have been a slight exaggeration in that picture, because it was stated in the testimony there were not sufficient supplies to carry it through the winter.

Admiral RICHMOND. In any decision like that there were two factors. One was extending the supplies for an indefinite period, plus the fact we have a lot of men, if locked in the ice, who are not gainfully employed, and there would be no point in keeping them sitting there if there were any way to get them out. So there were two factors involved; one was to obviate extending the supplies for an indefinite period, and the other to recapture as many men as possible from that position and have them gainfully employed.

Mr. GROSS. It is true, is it not, that even had this icebreaker been supplied with nuclear power it would not have been able to move if the phenomenon had not occurred and the ice opened?

Admiral RICHMOND. That is true.

Mr. GROSS. It would not have made any difference what the fuel supply.

Admiral RICHMOND. But at the time she was freed 6 or 8 months later, our point was she could last in that position longer than a conventionally fueled ship.

Admiral MUMMA. And that we agree with.

(Supplementary material to be found beginning on p. 168.)

The CHAIRMAN. There is a length of time during which the breakers can go in the ice and come out. It has been testified that is a 3-month period, isn't it? Three months is the safe period to go in and get out?

Admiral RICHMOND. That is correct on the fuel basis. The food supplies, and so forth, are geared for much longer.

The CHAIRMAN. The fuel is the question here.

Admiral RICHMOND. If there is no fuel you do not operate.

The CHAIRMAN. There is fuel for about a 3-month voyage, is that correct?

Admiral RICHMOND. Two and a half months, as I recall. Fuel capacity on one of the *Wind* class vessels under normal average operating conditions—that is, not steaming at full speed all the time—is estimated by us at two and a half months on the *Wind* ships. When you get into the fresh provision of food——

The CHAIRMAN. That is not what we are talking about.

Admiral RICHMOND. That enters into the question of taking them off the ship when they are frozen in.

The CHAIRMAN. But the fuel is of two and a half months' duration under ordinary conditions. Under extreme conditions it might be shorter?

Admiral RICHMOND. That is definitely so.

The CHAIRMAN. Any further questions?

Admiral, we appreciate very much your coming before us. We will submit this transcript of the record for further observation and report from the Navy.

If you will bear with us, we have one more witness from the Atomic Energy Commission. I think there are two witnesses here.

STATEMENT OF LOUIS H. RODDIS, DEPUTY DIRECTOR, DIVISION OF REACTOR DEVELOPMENT, ACCOMPANIED BY R. C. GODWIN, CHIEF, MARITIME REACTORS BRANCH, DIVISION OF THE REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

Mr. RODDIS. My name is Louis H. Roddis. I am Deputy Director of the Division of Reactor Development of the Atomic Energy Commission. The other witness is Mr. R. C. Godwin, Chief of the Maritime Reactors Branch of our Division and also he is an Assistant to the Maritime Administrator for Nuclear Propulsion. Mr. Godwin has been working on the technical aspects of this with the Coast Guard and is in charge of the work on the nuclear ship, the *Savannah*, both for the Atomic Energy Commission and the Maritime Administration.

I do not have a prepared statement, but with your permission I would like to read a brief letter in the record. It is the Atomic Energy Commission's letter of January 20, 1958, addressed to you, Mr. Chairman, which sets forth the Atomic Energy Commission's position in this matter.

The CHAIRMAN. Very well.

(Thereupon, the letter referred to was read into the record by Mr. Roddis as follows.)

ATOMIC ENERGY COMMISSION,
Washington, D. C., January 20, 1958.

Hon. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries,
House of Representatives.

DEAR MR. BONNER: In your letter of August 9, 1957, you requested the views and recommendations of the Atomic Energy Commission with regard to H. R. 9196, to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes. We are happy to furnish the following report:

The bill would authorize the appropriation to the Treasury Department, the Coast Guard, and the Atomic Energy Commission, of sums required for constructing and outfitting the proposed vessel and preparing it for operation, including training qualified personnel.

The Atomic Energy Commission, of course, is unable to advise you whether the Coast Guard will require the services of an additional icebreaker. We do feel, however, that if such a vessel will be needed, it would be not only feasible, but advantageous as well, to use a nuclear plant as a source of power. The reasons for this conviction are stated below.

In the performance of its tasks, an icebreaker might be required to spend prolonged periods of time at sea at high power output without opportunity for refueling. The use of nuclear fuel could meet this requirement in a superior fashion.

Likewise, nuclear power, since its weight change is less sensitive to increased power output, might result in a more efficient vessel as this characteristic of an icebreaker is a function of power per unit displacement.

Moreover, if sufficient time were allowed for research and development, the development and operation of the nuclear propulsion might contribute materially to the advancement of reactor technology.

The proposed icebreaker would probably be more expensive to construct than a conventionally powered ship. However, in view of the offsetting considerations stated above, the utilizatioin of a nuclear powerplant would appear to afford an excellent opportunity to demonstrate a peaceful use of atomic energy in a practical application. Accordingly, if the services of an additional icebreaker are required, we would recommend favorable consideration of H. R. 9196.

The Bureau of the Budget has advised us that is has no objection to the submission of the report.

Sincerely yours,

K. E. FIELDS, *General Manager.*

The CHAIRMAN. That evidently is subscribed to by the President, because he is always talking about the peaceful use of atomic energy, is that correct?

Mr. RODDIS. That is indeed true, sir.

I have three other points which I think I might usefully make.

The first of these concerns the question of cost and time. I have no idea whatever of the cost of an icebreaker, the hull. A nuclear propulsion plant for the type of ship we have been talking about, based on our knowledge of today's technology, would cost approximately $30 million for the complete plant. I would not like to put that in the framework of a budget estimate, because we do not know yet what it is we are talking about in detail, but that is a rough estimate of the cost of the propulsion plant for the type of ship we are talking about. To that should be added the cost of the hull and equipment.

Based on our experience with the Navy and the *Savannah*, a period of 3 years from the time the funds are available appears to be a reasonable time to get a propulsion plant installed in the ship. I have no idea of the time to design and build the ship.

The question was asked Admiral Mumma about how busy the reactor construction industry is. The Atomic Energy Commisison had meetings in early December with the reactor construction industry in this country. It is obvious that at the present moment there is substantial excess capacity. They are indeed asking for work. As an example of this, the one company that has the biggest backlog of nuclear business has just within the last few weeks signed a contract for a large civilian powerplant and is actively seeking more contracts. In fact, all the companies I know of in this industry are actively seeking more contracts. Whether this situation will be changed as a result of nuclear propulsion for submarines I do not know, but the situation as of today is that the industry is certainly not overly busy.

In connection with the proposed language amendment mentioned by Admiral Mumma at the end of the bill, the Commission is satisfied and would hope that the language that mentions the approval of the Atomic Energy Commission where appropriate remains in the bill.

The CHAIRMAN. Does that include your statement?

Mr. RODDIS. Yes, sir.

The CHAIRMAN. Any questions?

Mr. TOLLEFSON. I do not have any questions, but I cannot refrain from commenting on another hearing in this very room when there was opposition to the legislation, and I am pleased to listen to this testimony today. Neither can I refrain from commenting on the opposition to the bill when it was on the floor, some of which opposition was based upon the fact that there would not be sufficient capacity to build the nuclear propulsion plant, and you say there is an excess of capacity at this time?

Mr. RODDIS. At this time. That could be changed. I cannot say as to the shipbuilding industry as such, but as to the nuclear propulsion plant there are companies anxious to take on this type of work.

The CHAIRMAN. Any further questions? Mr. Allen.

Mr. ALLEN. In your opinion, what is the critical factor in making a decision about an icebreaker? Is it going to be competition for the fuel? You said it is not competition for the fuel. Is it going to be competition for the men who know how to operate the plants or how do you get the best results for the least money?

Mr. RODDIS. The latter, competition for dollars. The fuel problem is best answered by saying there has been made available 50 tons of enriched uranium for use abroad and 50 tons for use in this country. The amount necessary for several years for this type of ship is several pounds, so the fuel is by no means a problem.

As of the moment the situation on manpower is certainly not a controlling factor.

This leaves the dollar competition as to whether you can do better with something that costs less in the overall situation as the controlling factor.

Mr. ALLEN. Off the record.

(Discussion off the record.)

The CHAIRMAN. Mr. Gross.

Mr. GROSS. This would not be an experimental ship in any respect?

Mr. RODDIS. You mean the propulsion plant or the ship? This would depend very heavily on the time schedule you put on it.

Mr. GROSS. The question I wanted to ask is this. It has been demonstrated that you can satisfactorily power vessels with nuclear energy.

Mr. RODDIS Yes.

Mr. GROSS. Of course this is out of your field, but I wonder where we are going to go with the balancing of the budget if we are going to spend money at this rate. Where will we get the money?

Mr. RODDIS. Mr. Gross, that is not my department.

Mr. GROSS. It is not your department, but you are apparently supporting the construction of this expensive icebreaker.

Mr. RODDIS. I put a substantial amount in as a taxpayer. Aside from that, that is not my department, sir.

Mr. GROSS. That is all.

The CHAIRMAN. Any further questions?

Mr. PELLY. Mr. Chairman, this witness has raised a technical point that no other witness has done, and that is that with conventional fuel the weight of the ship varies from the time its fuel tanks are full and the time they are empty. I would like in the record some statement, maybe from Admiral Richmond, as to the efficiency of an icebreaker when it is full as compared to when it is practically empty. It seems to me that is quite an important qualification.

Mr. GROSS. Did I understand you to say, Mr. Roddis, that we are giving to foreign countries 50,000 tons of enriched uranium?

Mr. RODDIS. I said 50 tons, and I did not say give, I said made available.

Mr. GROSS. I will supply that word "give." How much does this uranium cost?

Mr. RODDIS. We sell it at $16 per gram. That is $16 million per metric ton.

Mr. GROSS. That is a nice gift.

Mr. RODDIS. This is aside from the point, but I would like the record to be clear that at no time have I heard mention of a gift of this nature. This is a question of making material available for sale

or for lease under some conditions that could not otherwise be made available by law without a Presidential directive.

Mr. GROSS. What kind of money will be used to pay us for this uranium?

Mr. RODDIS. I am not qualified to answer that.

Mr. PELLY. Mr. Chairman, could you ask Admiral Richmond to supply for the record a statement as to the relative efficiency of a nuclear-powered icebreaker and a conventional icebreaker?

Admiral RICHMOND. Off the record.

(Discussion off the record.)

The CHAIRMAN. Any further questions?

Mr. ALLEN. In regard to the fuel that is made available, is that privately owned or owned by the United States Government, and is it sold to other governments or to private individuals in commercial transactions?

Mr. RODDIS. By law it is the property of the United States Government in the United States and can only be leased to private individuals in the United States. Abroad all of the agreements which have been negotiated to date to my knowledge—and there may be some exceptions—provide for the sale of this material. There have been and undoubtedly will be more discussions on the question of whether it is sold or leased abroad. There is a rather long list of pros and cons on this.

Mr. ALLEN. Is it sold to other governments or to individuals, citizens of other governments?

Mr. RODDIS. Only to other governments and any arrangement between those governments and private individuals concerned is the arrangement of that government.

Mr. ALLEN. Thank you.

The CHAIRMAN. This has been a most interesting series of hearings. It has been informative to me and I am sure to other members of the committee. I am delighted with the favorable reaction we have from the witnesses and I want to thank the witnesses personally and on behalf of the committee for their tolerance with us and their attendance at the hearings.

(Thereupon, at 1:40 p. m., the hearing was adjourned.)

(Letters from Merchant Marine Institute, Inc., American Legion, and Dartmouth College, follow:)

AMERICAN MERCHANT MARINE INSTITUTE, INC.,
Washington, D. C., January 24, 1958.

Hon. HERBERT C. BONNER,
Chairman, Merchant Marine and Fisheries Committee,
House of Representatives, Washington, D. C.

DEAR CHAIRMAN BONNER: The American Merchant Marine Institute represents the owners and operators of vessels constituting a preponderance of the American merchant marine.

We wish to inform your committee of our support for H. R. 9196, introduced by yourself, H. R. 9978, introduced by Mr. Tollefson, and H. R. 10122, introduced by Mr. Pelly, authorizing the construction of a nuclear-powered icebreaker for the Coast Guard.

We believe no time should be lost in having available to the Coast Guard a vessel of the type called for in the aforementioned legislation since the Coast Guard has prime responsibility in connection with the safety and regulation of merchant vessels including their propulsion machinery.

The keel of the first commercial-type nuclear-propelled ship will be laid in but a few months and will be in operation within a reasonable time thereafter.

While it is hazardous to guess as to time, we feel certain that other vessels similarly propelled will be coming into service. The experience gained by the Coast Guard in connection with the operation of a nuclear-propelled vessel of its own will be of extreme value to that agency in properly performing its function in connection with the nuclear ship *Savannah* and others which may follow. It would be of great advantage to the Nation in general and specifically in the interest of the American merchant marine for the Coast Guard to be as up to date as possible in the handling and operation of new propelling machinery so that there will be no lag in their appreciation of and understanding of the complications which are implicit in nuclear propulsion, and the necessary regulation thereof.

That this experience might be gained by the Coast Guard in the operation of a nuclear-propelled icebreaker, seems to us particularly fortuitous. One has only to read of the Military Sea Transportation Service, under the skilled leadership of Admiral Will, pioneering in Arctic waters to appreciate how vast the navigational horizon in regions currently thought to be unnavigable because of ice.

In this connection we need not concentrate on the Arctic or Antarctic when right at our doorstep the St. Lawrence seaway, in spite of vast Government investments in its construction, is usable only 8 months per year.

It is not too early to think of the possibilities of new routings for merchant ships and the movement thereof in lanes never before navigated for commercial purposes. If the addition of nuclear propulsion to icebreaking functions will advance this endeavor, it will, I am sure, redound to the interest of our Nation and the citizens of the free world.

Sincerely yours,

ALVIN SHAPIRO.

THE AMERICAN LEGION,
Washington, D. C., February 12, 1958.

Hon. HERBERT C. BONNER,
Chairman, Merchant Marine and Fisheries Committee,
House of Representatives, Washington, D. C.

DEAR CHAIRMAN BONNER: The American Legion has consistently supported progress in our military forces, weapon systems, and in the services which supplement and contribute to the total national security.

We do not view the proposal for the construction of a nuclear-powered icebreaker in the narow sense that it is merely a new ship for the Coast Guard, but rather that it represents an opportunity for the Coast Guard to derive invaluable training in a new medium of power.

In a very real sense the United States is handicapped by its wealth of natural resources such as coal, electric and water power, and oil. If we were a "have not" nation we would have instituted a crash program to utilize nuclear power for all uses; commercial, military, and industrial.

The Soviet Union, it is reliably reported, has already built an atomic-powered icebreaker while we are still debating the wisdom of such a move. In the far reaches of the Arctic and Antarctic can there be any doubt as to desirability of having a vessel whose range and endurance is literally unlimited? So long as we propose to maintain interest in these new frontiers, so long as we are required to maintain and supply our early warning lines in the far north, the United States should authorize the construction of the type of vessel that best suits the demands of the area.

Nuclear propulsion is the power of the future. To delay now is merely to deter progress. The experience gained from the operation of a nuclear powered merchant icebreaker by the Coast Guard which has prime responsibility for the safety and regulation of merchant ships will serve them in good stead as our nuclear merchant marine comes into being.

The nuclear-powered *Savannah* will present new problems of operation, safety and maintenance, which the operational experience of the nuclear icebreaker will parallel.

In the best interests of the Nation and its future progress, I urge support for the bills presently under consideration by your committee.

Sincerely.

HENRY C. PARKE,
Chairman, National Merchant Marine Committee.

DARTMOUTH COLLEGE,
DEPARTMENT OF GEOGRAPHY,
Hanover, N. H., February 5, 1958.

Hon. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries, House of Representatives, House Office Building, Washington, D. C.

DEAR MR. BONNER: I have studied with interest the transcript of the hearings on your bill H. R. 9196 for the authorization of an atomic icebreaker and would like to volunteer a few brief comments.

First, by way of introduction, I am a research associate in geography at Dartmouth College and engaged in basic research in Arctic ice and oceanography. I have been active in polar work since 1935 and during the prewar years worked in the Greenland-Baffin Bay area as far north as Kane Basin on one of the few American ships then plying those waters. I participated in the wartime surveys of our Greenland bases, and in the postwar years have led numerous scientific expeditions to Labrador and Greenland waters. I have had icebreaker duty in the Antarctic. I am currently on the board of governors of the Arctic Institute of North America, the ONR–AINA Arctic Research Advisory Committee, a commander United States Navy Reserve, and a master United States Merchant Marine. Also for the past several years I have been serving as a special geographical and shipping consultant to the Ungava Bay iron ore interests.

1. The importance of the Arctic in its multiple aspects, together with our need for basic knowledge, has been clearly emphasized by the witnesses who appeared before your committee and through the Office of Naval Research-Arctic Institute report which was placed in the record.

2. I consider it a fundamental premise that it is in our national interest to have the highest possible operating capability in the Arctic. In this respect I think it is folly to consider present installations and requirements as fixed, for it takes little imagination to foresee that the DEW line will soon be obsolete. The requirements of tomorrow will be vastly different from those of today.

3. The greatest problem facing polar operations today is transportation; and the primary means of the transportation of the large tonnages required for both defense and industrial development is surface shipping.

4. In passing I would like to remark that I feel that the argument that the Soviets or Canadians are building an atomic icebreaker is irrelevant. Our decision to build such a ship must be based on our own requirements—not "keeping up with the Jones."

5. The atomic icebreaker is one answer to our goal of a continued Arctic capability. The arguments that we can get along at present with conventionally powered icebreakers are not convincing. Every year brings forth new and expanded requirements; and in any emergency the extension of the Arctic navigation season and icebreaker operations would be an obvious necessity.

6. To me the most important features and assets of an atomic icebreaker are:

(*a*) The endurance is virtually unlimited and would permit extension of the operating season to the limit and throughout the winter if necessary.

(*b*) The increase in power, size, and endurance would extend the operating area to regions now denied a conventional icebreaker, such as the Arctic Ocean itself.

(*c*) The provision of space and facilities for scientific research is an integral part of any modern icebreaker program. We must not only break ice, we must also understand ice.

(*d*) A significant cargo capacity should be an important feature in any new icebreaker. Although the primary mission of an icebreaker is to escort other ships to their destination, it is well known that certain stations and areas are only accessible to an icebreaker without convoy. It is conceivable that in such cases an atomic icebreaker might also tow underwater cargo and fuel barges.

7. The testimony as given brings out a most interesting facet to the whole plan, that it is a team project, a cooperative effort, with interests spread out among the Coast Guard, the Department of Defense, the Navy, the Atomic Energy Commission, MSTS, and the several agencies involved in polar science. I hope that the development of an atomic icebreaker, if authorized, would be undertaken as a cooperative national effort with the most careful and fullest

exploitation of all potentialities. Perhaps an advisory panel might be formed, which would be composed of representatives of the various Government agencies concerned, as well as civilian representatives from universities and such private organizations as the Arctic Institute whose basic concern is with polar science. This last thought is of course not a legislative matter, but one I feel to be important in intelligent implementation.

Sincerely yours,

DAVID C. NUTT.

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D. C., January 27, 1958.

Adm. ARLEIGH BURKE,
Chief of Naval Operations, Department of the Navy,
Washington 25, D. C.

DEAR ADMIRAL BURKE: The Committee on Merchant Marine and Fisheries has just completed public hearings on H. R. 9196, a bill to authorize the construction of a nuclear-powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes.

Under date of January 15, 1958, the Department of the Navy, on behalf of the Secretary of Defense, wrote that while such a ship would have some worthwhile military advantages, the introduction of the bill was premature, since its enactment might well delay the construction of other nuclear-powered vessels having a much higher priority.

During the course of testimony given by Rear Adm. A. G. Mumma, Chief of the Bureau of Ships, on Friday, January 24, he was assured that there was no intention that the bill should in any way interfere with vital projects for naval construction, and that the committee had no objection to modifying the bill accordingly.

However, inasmuch as preceding testimony strongly supported the concept of a nuclear-powered icebreaker with multipurpose capability, including such functions as polar research, maintenance of navigation, and search and rescue, as well as strictly military advantages, the committee considered it desirable to request that you have the entire record reviewed at your earliest convenience.

Accordingly, there are transmitted herewith transcripts of the testimony of all witnesses during hearings from January 22 to January 24, inclusive, for your consideration and further report.

In view of the emphasis laid on the utility of such a vessel in connection with much needed scientific research, I will appreciate it if you will specifically arrange for review of the record by the Office of Naval Research, as well as other branches of the Department of Defense which may be deemed appropriate.

Let me take this opportunity to express my personal appreciation for the cooperation which the Department of the Navy has rendered in connection with this proposed legislation.

Kindest regards and best wishes.

Sincerely,

HEBERT C. BONNER, *Chairman.*

DEPARTMENT OF THE NAVY,
OFFICE OF THE CHIEF OF NAVAL OPERATIONS,
Washington, D. C., March 10, 1958.

Hon. HERBERT C. BONNER,
Chairman, Committee on Merchant Marine and Fisheries,
House of Representatives, Washington 25, D. C.

MY DEAR MR. CHAIRMAN: Reference is made to your letter of January 27, 1958, requesting that the Chief of Naval Operations and the Office of Naval Research review the transcript of the hearings on H. R. 9196, a bill to authorize the construction of a nuclear powered icebreaking vessel for operation by the United States Coast Guard, and for other purposes.

A complete review of all operational aspects of nuclear icebreakers as well as the transcript of the hearings has been made by the Department of the Navy and it is recognized that a nuclear-powered icebreaker could be very useful to scientists and would have interesting scientific aspects. It could be extremely useful in obtaining much-needed scientific information in Arctic regions and, in particular, information on weather, bathymetry, physics of sea ice and currents, drift

and water structure for application to navigation, sonar propagation, and sea ice prediction as well as other hydrographic information. It is further recognized that there is a sense of urgency in acquiring such information.

Since 1934 there have been insufficient United States icebreakers to carry out all tasks desired. However, by operating continuously they have been able to carry out those high-priority tasks assigned. There is foreseen no reduction in the need for icebreakers in the near future. In fact, it is possible that further high-priority tasks might be assigned them without any reduction in those programs in which they are now engaged. Even realizing this situation, priority for building icebreakers has been below the budgetary limitation in the Navy's shipbuilding program so that construction of essential combatant types could be implemented. The Navy cannot, within its program, upgrade the icebreaker priority at this time.

The previous opposition of the Navy to enactment of H. R. 9196 was based primarily on the fact that construction of a nuclear-powered icebreaker might delay the construction of other nuclear vessels having a higher priority. Testimony given before your committee indicates that the United States industrial capacity for production of nuclear powerplants would not be taxed by the construction of a nuclear-powered icebreaker.

The testimony given on this bill before your committee not only has removed the principal basis of the previous objection by the Department of Defense, but it has also stressed the usefulness of a nuclear-powered icebreaking vessel and the need for acquiring the valuable information that this vessel would be able to obtain. Such information would be of great benefit to the Department of Defense and would be available to this Department at all times. While it is not possible for the Navy to upgrade the priority for the construction of a nuclear-powered icebreaking vessel within its own program at this time, nevertheless, the Navy and the Coast Guard work together very closely and if this vessel were built for the Coast Guard, it would undoubtedly be readily available to the Navy if high-priority tasks arose requiring its use. Accordingly, for the foregoing reasons, the Department of the Navy, on behalf of the Department of Defense, now supports enactment of H. R. 9196 dependent upon the needs of the Coast Guard.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Department of the Navy has been advised by the Bureau of the Budget that there is no objection to the submission of this report on H. R. 9196 to the Congress.

Sincerely yours,

ARLEIGH BURKE.

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